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BOX PATENT APPLICATION
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September 25, 2000

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Re: New U.S. Patent Application
DIGITAL CAMERA
By: Daigo YOSHIOKA and Masahito NIIKAWA
Attorney Docket: 15162/02440

Dear Sir:

Enclosed for filing are the following papers relating to
DIGITAL CAMERA, Daigo YOSHIOKA and Masahito NIIKAWA, inventors:

- (1) Specification (68 pages, including 17 claims and an abstract);
- (2) Executed Declaration and Power of Attorney (3 pages);
- (3) Formal Drawings (13 sheets);
- (4) Transmittal letter (2 pages) with PrintEFS Patent Application Bibliographic Data (2 pages);

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- (5) Transmittal letter (2 pages) with Certified Copy of Priority Document (81 pages);
- (6) Information Disclosure Statement (2 pages) with attached PTO-1449 form (1 page) and copies of the cited references (3 references); and
- (7) Assignment (2 pages) of the invention to MINOLTA CO., LTD., with attached Recordation Form Cover Sheet (1 page) (in duplicate).

jc841 U.S. PTO
09/669118
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The amount of the filing fee is calculated below:

			Fee for small entity		OR	Fee for other than small entity	
Fee	No. filed	No. extra *	Rate	Fee		Rate	Fee
Basic fee				\$345	OR		\$690
Total claims	17-20=	0	X \$9=	\$0	OR	X \$18=	\$-0-
Independent claims	2-3=	0	X \$39=	\$0	OR	X \$78=	\$-0-
Multiple Dependent Claim Presented	0	0	+\$130=	\$0	OR	+\$260=	\$-0-
			Total	\$0	OR	Total	\$690

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Please charge the required fees (\$690.00 for the application filing fee and \$40.00 for recordal of the Assignment) to Sidley & Austin's Deposit Account No. 18-1260. If additional fees are due, please charge any fees during the pendency of this application (other than the issue fee) to Deposit Account No. 18-1260. Please credit any overpayment to Deposit Account No. 18-1260.

This transmittal letter is being filed in duplicate.

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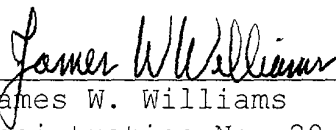
September 25, 2000

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All correspondence is to be directed to the Applicants' attorney at the Dallas address listed above.

Respectfully submitted,

By:



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JWW/mhg
Enclosures

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APPLICATION INFORMATION

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REPRESENTATIVE INFORMATION

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Registration Number Two:: 29160
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Registration Number Four:: 29753
Registration Number Five:: 31966
Registration Number Six:: 20047
Registration Number Seven:: 38595
Registration Number Eight:: 41341
Registration Number Nine:: 38425

PRIOR FOREIGN APPLICATIONS

Foreign Application One:: 11-276621
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Country:: JAPAN
Priority Claimed:: Yes

Source:: PrintEFS Version 1.0.1

DIGITAL CAMERA

This application is based on Patent Application
No. HEI 11-276621 filed in Japan, the content of which is
5 hereby incorporated by reference.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a digital
10 camera, and specifically relates to a digital camera
provided with an optical finder.

DESCRIPTION OF THE RELATED ART

In general, digital cameras are provided with a
15 display device such as a liquid crystal display device or
the like, the display device is used to display
regenerated or reproduced images photographed and
recorded, and display images during photography. The
user can set the composition and confirm the focus state
20 while viewing the displayed image during photography, and
the display device functions as a video finder. When the
display device is used as a finder, the power consumption
of the battery comprising the power source of the digital
camera is accelerated due to the large power consumption

of the display device, thereby reducing the time photography is possible.

Digital cameras are provided with an optical finder to avoid these disadvantages. Digital cameras

5 provided with an optical finder include the separate type wherein light is directed to a finder without mediation of the taking lens, and the single lens reflex (SLR) type wherein light passing through the taking lens is reflected and directed to the finder. In the separate
10 type, a parallax is generated between the finder and the taking lens, whereas essentially no parallax is generated in the SLR type.

The SLR type digital camera is provided with a mirror for reflecting light transmitted through a taking
15 lens and disposed on the optical path from the taking lens to the image sensing element, and a prism for directing the reflected light to the eye of a user and forming the viewed image as an erect image. This mirror may be a semitransparent mirror, which reflects part of
20 the light from the taking lens and directs it to a finder, and transmits the remainder of the light directing it to the image sensing element. In this construction, the optical finder and the video finder can be used simultaneously. However, when using a semitransparent
25 mirror, the light directed to the image sensing element

is only part of the light normally transmitted through the taking lens, such that excellent images cannot be obtained in a dark photographic environment.

In cameras of the SLR type using photosensitive silver halide film, it is well known that the entire reflective mirror is conventionally arranged so as to be inclined on the optical path from the taking lens to the film, and the mirror is retracted from the optical path by rotation. The mirror is disposed on the optical path directly before exposure of the film by photography, and the light directed to the prism is reflected, the mirror is retracted while the photograph is taken, light is directed to the film, and the mirror is controllably returned onto the optical path directly after photography. The mirror in this method is called a quick return mirror.

Japanese Patent Laid-Open Publication No. HEI 10-55023 (Unexamined) discloses a digital camera provided with a rotatable semitransparent mirror. The semitransparent mirror of this digital camera differs in purpose and operation from a conventional semitransparent mirror. This semitransparent mirror is integrated with a spatial low pass filter to reduce the high frequency component and an infrared cutting filter to eliminate light in the infrared range, such that when an image is sensed for recording, the mirror is not retracted from

the optical path, but is disposed on the optical path perpendicular to the optical axis of the taking lens. Accordingly, the light directed to the image sensing element is only part of the light normally transmitted through the taking lens, and the concern of reducing the quality of the photographic image due to insufficient light during photography is not resolved.

Furthermore, when the semitransparent mirror is arranged so as to be inclined relative to the optical path, i.e., when an optical finder can be used, the image sensing element is used as a focus detector for autofocusing, and the image sensed by the image sensing element cannot be used as a video finder.

SUMMARY OF THE INVENTION

An object of the present invention is to eliminate the previously described disadvantages by providing a digital camera having a versatile finder.

These objects are attained in one aspect of the present invention of a digital camera comprising an image sensing element disposed at a position at which is formed an image by a taking lens; a recording unit for recording on a recording medium an image sensed by the image sensing element in accordance with recording instructions from outside the recording unit; a semitransparent mirror

which rotates about an axis in a direction perpendicular to the optical axis of the taking lens so as to move between an advanced position intersecting at an inclination the optical path from the taking lens to the image sensing element, and a retracted position removed from the optical path from the taking lens to the image sensing element; and an optical finder providing an image by directing the light reflected by the semitransparent mirror set at the advanced position from the taking lens to the eye of an user.

The semitransparent mirror is a quick return mirror. The image sensing element receives light for photography from the taking lens whether the semitransparent mirror is set at the advanced position or retracted position. Accordingly, an image can be sensed and recorded or displayed regardless of the position of the semitransparent mirror. When the semitransparent mirror is set at the advanced position, the optical finder can also be used. When the mirror is set at the retracted position, all of the light from the taking lens is directed to the image sensing element, such that there is no insufficiency of light in the sensed image at this time.

The image sensing element is movable between a first position and a second position. The first position

and the second position are set so as to attain
equivalency of the light entering the first position
directly when the semitransparent mirror is set at the
retracted position, and the light entering the second
5 position through the semitransparent mirror when the
semitransparent mirror is set at the advanced position.

Although there is a difference in the optical
path from the taking lens to the image sensing element
depending on whether the semitransparent mirror is set at
10 the advanced position or the retracted position, the
image provided by the optical finder can match the image
sensed by the image sensing element by changing the
position of the image sensing element in accordance with
the position of the semitransparent mirror. In this way
15 there is greater freedom in selecting the position of the
semitransparent mirror without requiring a fixed 1-to-1
correspondence of the positions of the semitransparent
mirror whether or not the sensed image is used, i.e.,
whether or not recording or displaying.

20 The taking lens is movable between a first
position and a second position in a direction along the
optical path. The first position and the second position
are set so as to equalize the optical path length from
the first position directly to the image sensing element
25 when the semitransparent mirror is set at the retracted

position, and the optical path length from the second position through the semitransparent mirror to the image sensing element when the semitransparent mirror is set at the advanced position.

5 The difference in the optical path length depending on the position of the semitransparent mirror is eliminated by changing the position of the taking lens in accordance with the position of the semitransparent mirror, such that the image provided by the optical
10 finder can match the image sensed by the image sensing element. In this way there is greater freedom of selection of the position of the semitransparent mirror similar to a construction moving the image sensing element.

15 This digital camera has a first photographic mode wherein the semitransparent mirror is set at the advanced position until recording is instructed, and set at the retracted position when recording has been instructed, and returns to the advanced position again
20 when the image sensing element completes the sensing of the image, and a second photographic mode wherein the semitransparent mirror is set at the advanced position regardless of whether or not there is recording is instructed, and switches between the first photographic
25 mode and the second photographic mode in accordance with

switching instructions from the outside. Since the semitransparent mirror does not rotate in the second photographic mode, no vibration is generated.

Another aspect of the present invention is a
5 digital camera comprising an image sensing element disposed at a position at which is formed an image by a taking lens; a display unit for displaying an image sensed by the image sensing element; a recording unit for recording on a recording medium an image sensed by the
10 image sensing element in accordance with recording instructions from outside the recording unit; a semitransparent mirror which rotates about an axis in a direction perpendicular to the optical axis of the taking lens so as to move between an advanced position
15 intersecting at an inclination the optical path from the taking lens to the image sensing element, and a retracted position removed from the optical path from the taking lens to the image sensing element; and an optical finder providing an image by directing the light reflected by
20 the semitransparent mirror set at the advanced position from the taking lens to the eye of an user; this digital camera having a first photographic mode wherein the semitransparent mirror is set at the advanced position until recording is instructed, and set at the retracted
25 position when recording has been instructed, and a second

photographic mode wherein the semitransparent mirror is set at the retracted position regardless of whether or not the recording is instructed, and switches between the first photographic mode and the second photographic mode
5 in accordance with switching instructions from the outside.

In the first photographic mode the display unit used as a finder and the optical finder are usable simultaneously, and in the second photographic mode the
10 only the display unit is usable. The optical finder image advantageously does not blur even when the photographic object moves quickly, and the image displayed on the display unit advantageously expresses the true color balance of the recorded image. Both these
15 advantages occur in the first photographic mode, and since the semitransparent mirror does not rotate in the second photographic mode, no vibration is generated.

In this digital camera also, the difference in the optical path depending on the position of the
20 semitransparent mirror can be eliminated by changing the position of the image sensing element or the taking lens in accordance with the position of the semitransparent mirror so as to set the image sensing element or the taking lens at two positions as they are movable.

Yet another aspect of the present invention is a digital camera comprising an image sensing element disposed at a position at which is formed an image by a taking lens; and an optical element movable between an advanced position intersecting at an inclination the optical path from the taking lens to the image sensing element, and a retracted position removed from the optical path from the taking lens to the image sensing element; this digital camera having a first photographic mode wherein the optical element is set at an advanced position for photography, and a second photographic mode wherein the optical element is set at a retracted position for photography, and the optical path lengths from the taking lens to the image sensing element are equalized in the first photographic mode and the second photographic mode by moving the taking lens in a direction along the optical axis of the taking lens.

The optical element is a single element or a compound element for photography such as a semitransparent mirror, infrared cutting filter, spatial modulation element, ND filter or the like. Furthermore, the optical element may be set at an advanced position or a retracted position by rotation, or may be set at both positions by movement other than rotation.

Still another aspect of the present invention is a digital camera comprising an image sensing element disposed at a position at which is formed an image by a taking lens; and an optical element movable between an
5 advanced position intersecting at an inclination the optical path from the taking lens to the image sensing element, and a retracted position removed from the optical path from the taking lens to the image sensing element; this digital camera having a first photographic
10 mode wherein the optical element is set at an advanced position for photography, and a second photographic mode wherein the optical element is set at a retracted position for photography, and the light entering the image sensing element is equalized in the first
15 photographic mode and the second photographic mode by moving the image sensing element.

These and other objects, advantages and features of the invention will become apparent from the following description thereof taken in conjunction with
20 the accompanying drawings, which illustrate specific embodiments of the invention

BRIEF DESCRIPTION OF THE DRAWINGS

In the following description, like parts are designated by like reference numbers throughout the several drawings.

FIG. 1 is a top view of the digital camera of a first embodiment of the present invention;

FIG. 2 is a sectional view of the digital camera of FIG. 1;

FIG. 3 is a back view of the digital camera of FIG. 1;

FIG. 4 is a front view and sectional view of the CCD unit displacement mechanism of the digital camera of FIG. 1;

FIG. 5 is a block diagram briefly showing the circuit structure of the digital camera of FIG. 1;

FIG. 6 is an exploded perspective view of the quick return mirror drive mechanism of the digital camera of FIG. 1;

FIG. 7 is a sectional view showing the relationship of the taking lens and the mirror support base in the digital camera of FIG. 1;

FIG. 8 is a flow chart showing the processing flow of the drive control of the CCD unit and quick return mirror in conjunction with photographic mode change in the digital camera of FIG. 1;

FIG. 9 is a flow chart showing the processing flow of the operation control during photographic image recording in the digital camera of FIG. 1;

FIG. 10 is a flow chart showing the processing flow of the LCD ON/OFF control in the digital camera of FIG. 1;

FIG. 11 is a sectional view of a digital camera of a second embodiment of the present invention;

FIG. 12 shows an example of the CCD pixel setting of the digital camera of FIG. 11, and an example of the usage range of the pixels of the CCD in accordance with the position of the quick return mirror;

FIG. 13 shows an example of the positional relationship of the screen and the photographic frame displayed in the optical finder when the quick return mirror is set at the advanced position in the digital camera of FIG. 11; and

FIG. 14 shows an example of the LCD display when the quick return mirror is set at the advanced position in the digital camera of FIG. 11.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

the embodiments of the present invention are described hereinafter with reference to the accompanying drawings. FIGS. 1, 2, and 3 are, respectively, a top

view, section view viewed from the side, and back view of the digital camera 1 of a first embodiment. The digital camera 1 comprises a camera body 2, a taking lens 301 detachably attached to the camera body 2, and an optical finder 22. A grip G is formed on the camera body 2 to allow the camera to be held by a user, and a shutter release button 9 is provided at the top of the grip G. The interior of the grip G forms a battery compartment, which accommodates four "AA"-size batteries. A power switch PS is provided on the top of the camera body.

The camera body 2 is an SLR type provided with a quick return mirror. A quick return mirror M1 having at one end a rotating shaft in a direction perpendicular to the optical axis of the taking lens 301 rotates from a position (this is the advanced position indicated by the solid line in FIG. 2) intersecting the optical axis of the taking lens 301 at an angle of 45° to a position (this is the retracted position indicated by the dashed line in FIG. 2) on the finder 22 side outside the optical path, and the focal plane shutter 26 opens when the shutter release button 9 is pressed. In this way the light transmitted through the taking lens 301 forms an image on the image sensing element, i.e., CCD 302, and the image is sensed by converting the light received by each pixel

of the CCD 302 to an electrical signal. The CCD 302 is accommodated within the CCD unit 303.

the taking lens 301 is a zoom lens comprising a first lens unit 3102 and a second lens unit 3103. The first lens unit 3102 is driven by a zoom motor 3104 provided inside a lens barrel 3011. The entire taking lens 301 has a variable focal length by changing the spacing of the first lens unit 3102 and the second lens unit 3103 so as to realize the zoom function.

A stepping motor 221 is provided within the camera body 2 to drive the taking lens 301, and the rotating shaft of the stepping motor 221 is connected to a screw 2211. The screw 2211 engages a connecting hole 3014 provided at the back end of the lens barrel 3011, such that the entire taking lens 301 is moved in the direction of the optical axis of the taking lens 301 by the rotational drive of the stepping motor 2211. In this way focusing adjustment is accomplished for the taking lens 301. In the digital camera 1, the taking lens 301 is moved in the direction indicated by the arrow A in FIG. 2 such that the majority part of the taking lens 301 is housed within the camera body 2 when not in use. The housing of the taking lens 301 in the camera body 2 is also accomplished by the motor 221.

A stop 3105, and stop control driver 3106 are provided within the lens barrel 3011 of the taking lens 301, and an ND filter 3107 for light adjustment, and an actuator 3108 for advancing and retracting this ND filter
5 in the optical path are provided.

The quick return mirror M1 is a semitransparent mirror, and a reflective film is provided on the surface on the taking lens 301 side. The transmittancy of the mirror M1 is set at 70%; accordingly, 30% of the light
10 transmitted through the taking lens 301 is directed to the finder 22 side even when the mirror M1 is set at the advanced position, and the remaining 70% of the light is directed to the CCD 302 side. For this reason, photography is possible not only when the mirror M1 is
15 set at the retracted position, but also when the mirror M1 is set at the advanced position. In the digital camera 1, it is possible to select a photographic mode wherein the quick return mirror M1 is rotated to the retracted position in accordance with the operation of
20 the shutter release button 9, as well as a photographic mode wherein the quick return mirror M1 stops at the advanced position via the operation of the shutter release button 9. In the latter mode, a user can verify the composition in the optical finder 22 during
25 photography by the CCD 302.

The CCD unit 303, in addition to the CCD 302, is provided with an integrated spatial low pass filter 304 for controlling the frequency characteristics of the light received by the CCD 302, and infrared cutting filter 304 for correcting the spectral sensitivity characteristics of the CCD 302. When the quick return mirror M1 remains at the advanced position during photography, the CCD unit 303 is displaced in the direction indicated by the arrow A3 in FIG. 2 by a drive unit 306, so as to compensate for the difference in the optical path as when the mirror M1 is set at the retracted position. That is, when the mirror M1 is set at the advanced position, the focal position is displaced in the arrow A3 direction compared to when the mirror M1 is set at the retracted position, such that the focal position is corrected by this displacement to behind and below the CCD unit 303.

The difference in the optical path length is eliminated by the displacement of the CCD unit 303 front and back directions, and the difference in the image forming position of the light on the CCD 302 is eliminated by displacement in the vertical directions. The amount of displacement of the CCD unit 303 is set in consideration of the thickness and refractive index of the mirror M1, and the inclination relative to the

optical axis of the taking lens 301 at the advanced position.

The mechanism 307 for displacing the CCD unit 303 is shown in FIG. 4. In FIG. 4, (a) is a front view of the displacement mechanism 307, (b) is a sectional view of the displacement mechanism 307 when the CCD unit 303 is not displaced, i.e., when the mirror M1 is set at the retracted position, and (c) is a sectional view of the displacement mechanism 307 when the CCD unit 303 is displaced, i.e., when the mirror M1 is set at the advanced position.

The CCD unit 303 has a cross section that is a parallelogram, and the four side surfaces contact the guides 307a, 307b, 307c, 307d, so as to be oscillatable. The guides 307a~307d are fixedly attached to the camera body 2. On the side of the guide 307d is formed a slot along the displacement direction of the CCD unit 303, and a connector 306a integrally formed with the CCD unit 303 protrudes from this slot to the outside. On the exterior side of the guide 307d is fixedly attached a drive unit 306 for driving the CCD unit 303.

The drive unit 306 comprises a cylinder 306c and a plunger 306b which slides inside the cylinder, such that the plunger 306b is moved by an electromagnet provided within the cylinder 306c. The tip of the

plunger 306b is connected to the connector 306a provided on the CCD unit 303.

In addition to an electromagnet, permanent magnets are provided on the plunger 306b and the cylinder 306c of the drive unit 306. These permanent magnets are arranged such that the in-line direction of both poles matches the direction of movement of the plunger. The direction from the N-pole to the S-pole is reversed for the permanent magnet of the plunger and the permanent magnet of the cylinder, and the distance between both poles of the magnet of the plunger is set to approximately one half the distance between both poles of the magnet of the cylinder. Accordingly, when current is not applied to the electromagnet, the plunger is stably maintained at two places, i.e., a position at which the N-pole of the plunger faces the S-pole of the cylinder, and a position at which the S-pole of the plunger faces the N-pole of the cylinder.

According to this construction, the drive unit 306 is a self-maintained type supporting the position of the movable plunger 306b at two places without an external force. The electromagnet generates a larger attraction force than the permanent magnets of the plunger and cylinder, so as to move the plunger. The strength of the permanent magnets of the plunger and

cylinder is set low so as to be within a range that does not move the plunger under a slight impact, and the power consumption of the electromagnet is slight. Furthermore, after the plunger is moved, it is no longer necessary to
5 supply a current to the electromagnet, and there is no power consumption other than for movement.

When power is applied to the drive unit 306 in the forward direction with the CCD unit 303 at the position on the front side (top) of the camera body 2 as shown in section (b) of FIG. 4), the plunger 306b is
10 moved in the arrow A3 direction, and the CCD unit 303 is moved in the same direction. The CCD unit 303 is stopped when abutting the back ends 307e and 307f of the guides 307a and 307b, and is positioned at the back side
15 (bottom) of the camera body 2 as shown in section (c) of FIG. 4. When power is applied to the drive unit 306 in the reverse direction with the CCD unit 303 positioned at the back side as shown in section (c) of FIG. 4, the plunger 306b is moved in the arrow A4 direction, and the
20 CCD unit 303 is moved in the same direction. The CCD unit 303 is stopped when abutting the front ends 307g and 307h of the guides 307a and 307b, and is positioned at the front side indicated in section (b) of FIG. 4.

One self supporting position of the plunger
25 306b of the drive unit 306 is set slightly behind the

back ends 307e and 307f of the guides 307a and 307b, and the other self supporting position is set slightly in front of the front ends 307g and 307h of the guides 307a and 307b. For this reason a force is exerted on the CCD unit 303 to press the back ends 307a and 307b or the front ends 307g and 307h, such that the position of the CCD unit 303 is determined by the guides 307a and 307b. Accordingly, the position of the CCD unit 303 is precisely determined.

Although self support of the drive unit 306 is realized using the attraction force of the permanent magnets, the CCD unit 303 also can be pressed to the front side or the back side of the guides 307a and 307b by the repulsion force of the permanent magnets.

Alternatively to using a self supporting type drive unit 306, the CCD unit 303 may be maintained on the back side by a spring when current is not applied, and moved to the front side against the force exerted by the spring when current is applied. Conversely, the CCD unit 303 may be maintained on the front side by a spring when current is not applied, and moved to the back side against the force exerted by the spring when current is applied. The CCD unit 303 can be returned to the back side or the front side by stopping the current applied to the drive unit 306.

As shown in FIG. 2, a focusing screen 220, pentagonal roof prism 225 and eyepiece lens 226 are provided within the finder 22 of the digital camera 1. The optical path length from the intersection point B of the mirror M1 and the optical axis of the taking lens 301 to the screen 220 when the quick return mirror M1 is set at the advanced position, and the optical path length from the intersection point B to the photoreceptor surface of the CCD 302 when the CCD unit 303 is set at the front side position (section (b) of FIG. 4) are set so as to be equal. Accordingly, when the mirror M1 is moved to the retracted position for photography after confirming the focus state by the image formed on the screen 220, a focused photographic image is ensured even if the CCD unit 303 is not moved to the back side position (section (c) of FIG. 4).

The digital camera 1 may accept the installation of a memory card 8 for recording photographed images. The memory card 8 is removably installed, and is inserted within the finder 22 as shown in FIGS. 1 and 3. A slot for inserting the memory card 8 is provided on the right side of the finder 22.

As shown in FIG. 3, a liquid crystal display (LCD) 212 is provided on the back side of the camera body

2. The LCD 212 functions as a video finder by directly

displaying the image sensed by the CCD 302. The LCD 212 also can display the reproduction of an image recorded on the memory card 8. A display button 213 is provided on the back of the camera body 2 for switching ON/OFF the LCD 212. The power to the LCD 212 is switched ON or OFF each time the displayed button 213 is pressed.

A mode selection dial MODE is provided on the top of the optical finder 22 for setting the operating mode such as a photographic mode of the digital camera 1.

The digital camera 1 has three photographic modes using the finder. These three photographic modes are: the optical finder mode 1 (OF1), optical finder mode 2 (OF2), and liquid crystal finder mode (LCD). The optical finder modes 1 and 2 are modes using both the optical finder 22 and the LCD 212, and the liquid crystal finder mode is a mode using only the LCD 212.

In the optical finder mode 1, the quick return mirror M1 is moved to the retracted position when photographing an image to be recorded, and at other times the mirror M1 is held at the advanced position. In the optical finder mode 2, the quick return mirror M1 is normally held at the advanced position. In the liquid crystal finder mode, the quick return mirror M1 is normally held at the retracted position. Table 1 shows the position of the quick return mirror M1, ON/OFF of the

LCD 212, valid/invalid display button 213, and position of the CCD unit 303 when recording an image and at other times.

Table 1

5	Optical finder mode 1 (OF1)		
	Setting	Nonrecording photo	Recording photo
	Mirror M1	Retracted	Retracted
10	LCD 212	ON or OFF	ON or OFF
	Display		
	button 213	Valid	Valid
	CCD unit 303	Back position (LCD ON) Front position (LCD OFF)	Front position
15	-----		
	Optical finder mode 2 (OF2)		
20	Setting	Nonrecording photo	Recording photo
	Mirror M1	Advanced	advanced
	LCD 212	ON or OFF	ON or OFF
	Display		
25	button 213	Valid	Valid
	CCD unit 303	Back position	Back position

30	Liquid crystal finder mode (LCD)		
	Setting	Nonrecording photo	Recording photo
	Mirror M1	Retracted	Retracted
35	LCD 212	ON	ON
	Display		
	button 213	Valid	Valid
	CCD unit 303	Front position	Front position

40 In the optical finder modes 1 and 2, the display button 213 is operational, and the ON/OFF state of the LCD 212 is switched in accordance with the

operation of the display button 213. In the liquid crystal finder mode, the operation of the display button 213 is invalid, and the LCD 212 is forcibly set to the ON state. In the liquid crystal finder mode, although a situation arises wherein no finder image is obtained when the operation of the display button 213 is valid at this time because no image is formed in the optical finder 22, confusion of the user is avoided by forcibly turning ON the LCD 212 to display a projection image.

In each photographic mode excluding the non-recording image photography of the optical finder mode 1, the position of the CCD unit 303 is set at either the front side as shown in section (b) of FIG. 4, or the back side as shown in section (c) of FIG. 4 in accordance with the quick return mirror M1 being set at either the advanced position or the retracted position. Accordingly, excluding a short period when the photographic mode is switched and the LCD 212 is switched ON/OFF in the optical finder mode 1, there is no dislocation of the focal point caused by a difference in position of the mirror M1 in the image displayed on the display 212.

If the LCD 212 is OFF in the optical finder mode 1, the CCD unit 303 is set at the front position even when the quick return mirror 1 is at the retracted position. When, in this state, the display button 213 is

operated to start the display on the LCD 212, the display does not start immediately, but rather the display starts after the CCD unit 303 completes the movement to the back side. For this reason an unfocused condition in the images sensed one by one in a predetermined time interval by the CCD 302 is not displayed on the display 212.

The circuit structure of the digital camera 1 is briefly shown in FIG. 5. The digital camera 1 is provided with a general controller 211, and a camera control CPU 220. The general controller 211 controls photography by the CCD 302 and the processing of the signals output therefrom, and monitors the setting state and input operation of the operation unit 250 including the switches provided on the digital camera 1, i.e., the shutter release button 9, power switch PS, display button 213 and the like. The general controller 211 also controls the ON/OFF switching of the LCD 212, and the reading/writing of the memory card 8.

The camera control CPU 220 controls the various parts not controlled by the general controller 211, such as the quick return mirror M1, CCD unit displacement mechanism 307, focal plane shutter 26 and the like, and also controls the general controller 211. The general controller 211 and the camera control CPU 220 exchange

information required for control, and the camera control CPU 220 also performs all controls relating to the taking lens 301. For example, focusing control of the taking lens 301 via the lens drive motor 221 and housing the taking lens 301 in the camera body 2, adjustment of the stop 3105 via the stop control driver 3106, and setting the ND filter 3107 via the actuator 3108.

The digital camera 1 is provided with a timing control circuit 202, timing generator 214, signal processing circuit 213, A/D converter 205, black level correction circuit 206, WB (white balance) circuit 207, gamma correction circuit 208, and image memory 209 for photography by the CCD 302 and processing the signal output therefrom, and is provided with a VRAM 210 for image display by the LCD 212.

The CCD 302 has three types of pixels alternating in a fixed two-dimensional pattern to selectively photoelectrically convert the R (red), G (green), and B (blue) color components of the light. The CCD 302 converts the optical image of a photographic object formed by the lens 301 to R, G, B color component image signals (signals comprising a row of pixel signals generated by photoelectric conversion of each pixel) for output.

The timing generator 214 generates various timing pulses for controlling the operation of the CCD 302. Generation of the timing pulses is based on a standard clock signal from the timing control circuit 202.

- 5 The timing pulse generated by the timing generator 214 and supplied to the CCD 302 includes for example, photoelectric conversion control signal for specifying the start/end (exposure start/end) of an integral, and reading control signal (horizontal synchronization signal, vertical synchronization signal, transfer signal and the like) specifying the output time of each pixel.

The signal processing circuit 213 performs specific analog processing of the image signals (analog signals) output from the CCD 302. Specifically, the signal processing circuit 213 has a CDS (correlation double sampling) circuit and an AGC (auto gain control) circuit, wherein the CDS circuit reduces noise in the image signal, and the AGC circuit adjusts the level of the image signal by adjusting the gain.

- 20 The A/D converter 205 converts each analog pixel signal included in the image signal to a 10-bit digital signal. This A/D conversion is executed based on an A/D conversion clock signal supplied from the timing control circuit 202.

The black level correction circuit 206 corrects the black level of the A/D converted pixel; signal (hereinafter referred to as "pixel data") to a standard black level.

5 The WB circuit 207 performs level conversion of the pixel data of each R, G, B color component to adjust the white balance. This level conversion is to control the white balance to a level in which the white balance is properly adjusted after gamma correction. The WB
10 circuit 207 converts the level of the pixel data of each R, G, B color component with reference to a level conversion table within the general controller 211. The conversion coefficient (characteristic slope) of each color component of the conversion table is set for each
15 photographic image by the general controller 211.

The gamma correction circuit 208 corrects the gamma characteristic of the pixel data. The gamma correction circuit 208 has 6 types of gamma correction tables of differing gamma characteristics, and performs
20 gamma correction using a gamma correction table determined beforehand in accordance with the photographic scene and photographic conditions.

The image memory 209 temporarily stores the pixel data output from the gamma correction circuit 208.

25 The image memory 209 stores one frame of pixel data. The

CCD 302 comprises 1600x1200 (horizontal x vertical) pixels; the image memory 209 has a storage capacity to store 1600x1200 pixels, and the pixel data correspond to the pixel positions on the CCD 302.

5 The VRAM 210 is a buffer memory for storing pixel data of the image shown on the LCD display 212. The LCD 212 has 400x300 (horizontal x vertical) pixels, and corresponds to the storage capacity of the VRAM 210.

10 When the LCD 212 is turned ON for photography, the pixel data of the image sensed each 1/30 sec by the CCD 302 are processed by the previously mentioned circuits from the A/D converter 205 through the gamma correction circuit 208, and subsequently stored in the image memory 209, as well as transmitted to the VRAM 210
15 via the general controller 211 so as to display the image on the LCD 212. The user sets the composition while viewing this display, and is able to confirm the focus state of the taking lens 301 relative to the photographic object. In the reproduction mode, an image read out from
20 the memory card 8 is subjected to predetermined signal processing by the general controller 211 and thereafter transferred to the VRAM 210 and displayed on the LCD 212.

A card I/F 215 is an interface for writing image data to the memory card 8, and reading image data from the memory card 8.

Although not shown in the drawing, the general
5 controller 211 is provided with a filter unit for a filtering process used in the recording process of the photographed image, and a recording image generator for generating a compressed image and thumbnail image, and is
10 further provided with a reproduced image generator for generating a reproduced image to display an image recorded in the memory card 8 on the LCD 212.

The filter unit corrects the high frequency component of the image to be recorded by digital filtering to adjust image quality relating to contours.
15 The recording image generator reads pixel data from the image memory 209, and generates a compression image and thumbnail image for recording on the memory card 8. The recording image generator generates a thumbnail image by raster scanning the image memory 209, and reading pixel
20 data separated at specific intervals in the horizontal direction and the vertical direction. The read image data are sequentially transferred to the memory card 8, and the generation and recording of the thumbnail image are executed in parallel. The thumbnail image is
25 recorded in a thumbnail image area of the memory card 8.

The recording image generator reads all pixel data from the image memory 209, and subjects all pixel data to two-dimensional DCT (discrete cosine transform), and specific compression processing via the JPEG method such as Huffman coding to generate a compressed image. The generated compressed image is transferred to the memory card 8 and recorded in the main image area.

When photography is specified by the operation of the shutter release button 9, the general controller 211 generates a compressed image and thumbnail image from the pixel data recorded in the image memory 209, and records both images and tag information (i.e., frame number, exposure value, shutter speed, date/time of photograph, scene information, image results and the like) relating to the photographic images in the memory card 8.

The camera control CPU 220 also controls the power supplied from the power unit E comprising a battery or the like. When the power switch PS is operated to specify stopping the power supply, the camera control CPU 220 issues a stop signal to the power unit E, and the power unit E stops the supply of power in accordance with this signal.

The drive mechanism of the quick return mirror M1 is described below with reference to FIG. 6. The

quick return mirror M1 is fixedly attached via an adhesive to a holding frame 122 having a large opening, and the holding frame 122 is supported on a mirror base 123 functioning as a support member. The holding frame 122 has arms protruding from the sides near the ends of the frame, and holes 122a and 122b are formed in these arms. The mirror base 123 has an opening of a size identical to the opening of the holding frame 122, and holes 123a and 123b are formed at a position corresponding to the holes 122a and 122b of the holding frame 122.

A shaft 125a is inserted through the hole 122a of the holding frame 122 and the hole 123a of the mirror base 123, and a shaft 125b is inserted through the holes 122b and 123b. The shafts 125a and 125b are on the same straight line, such that the holding frame 122 is rotatable relative to the mirror base 123 about the shafts 125a and 125b.

The mirror base 123 is arranged at an inclination on the optical path from the taking lens 301 to the CCD 302 with the shafts 125a and 125b align in a direction perpendicular to the optical axis of the taking lens 301, so as to have the shafts 125a and 125b on the back side (CCD302 side), and top side (optical finder 22 side) when viewed from a position crossing the optical

axis. Although the holding frame 122 is rotatable, it is regulated at one end of the rotation range by abutting the mirror base 123. When the holding frame 122 abuts the mirror base 123, the quick return mirror M1 is set at the advanced position at an angle of 45° relative to the optical axis of the taking lens 301.

A drive unit 124 is provided on the side of the mirror base 123 for rotating the mirror M1 together with the holding frame 122. The drive unit 124 comprises a cylinder 124c, and a plunger 124b oscillating within the cylinder, such that the plunger 124b is caused to move by an electromagnet provided within the cylinder 124c. The cylinder 124c is fixedly attached to the mirror base 123 by a screw 124d. Fixedly attached the tip of the plunger 124b is a connector 124a comprising two parallel protrusions 124x and 124y, and a protrusion 122z provided on the arm of the holding frame 122 passes through a space 124z between the protrusions 124x and 124y. The protrusion 122z of the holding frame 122 is oscillatable within the space 124z.

When the holding frame 122 abuts the mirror base 123 and the mirror M1 is set at the advanced position, the drive unit 124 is in a state wherein the plunger 124b is shallowly inserted in the cylinder 124c.

In this state, when a current is supplied to the drive unit 124 in the forward direction, the plunger 124b moves in the arrow A5 direction, and is deeply inserted into the cylinder 124c. In this way the protrusion 122z of the holding frame 122 slidably moves within the space 124z, producing rotation in the arrow A7 direction about the shafts 125a and 125b, such that the quick return mirror M1 is moved to the retracted position together with the holding frame 122.

When a current is supplied to the drive unit 124 in the reverse direction with the mirror M1 set at the retracted position, the plunger 124b moves in the arrow A6 direction, and returns to the shallow insertion position in the cylinder 124c. In this way the protrusion 122z of the holding frame 122 slidably moves within the space 124z, producing rotation in the arrow A8 direction about the shafts 125a and 125b, such that the quick return mirror M1 is moved to the advanced position at which the holding frame 122 abuts the mirror base 123.

The drive unit 124 for driving the quick return mirror M1 is a self supporting type similar to the drive unit 306 of the displacement mechanism 307 of the CCD unit 303 previously described. Specifically, in addition to an electromagnet, permanent magnets are provided on the plunger 124b and the cylinder 124c of the drive unit

124. These permanent magnets are arranged such that the in-line direction of both poles matches the direction of movement of the plunger. The direction from the N-pole to the S-pole is reversed for the permanent magnet of the plunger and the permanent magnet of the cylinder, and the distance between both poles of the magnet of the plunger is set to approximately one half the distance between both poles of the magnet of the cylinder. Accordingly, when current is not applied to the electromagnet, the plunger is stably maintained at two places, i.e., a position at which the N-pole of the plunger faces the S-pole of the cylinder, and a position at which the S-pole of the plunger faces the N-pole of the cylinder.

The electromagnet generates a larger attraction force than the permanent magnets of the plunger and cylinder, so as to move the plunger. The strength of the permanent magnets of the plunger and cylinder is set low so as to be within a range that does not move the plunger under a slight impact, and the power consumption of the electromagnet is slight. Furthermore, after the plunger is moved, it is no longer necessary to supply a current to the electromagnet, and there is no power consumption other than for movement.

One self-supporting position of the plunger 124 of the drive unit 124 is set so as to be slightly

shallower within the cylinder 124c than the position at which the holding frame 122 abuts the mirror base 123. For this reason a force is exerted on the holding frame 122 pressing against the mirror base 123, and the mirror M1 advanced position is determined by the mirror base 123. Accordingly, the advanced position of the mirror M1 is precisely determined.

On the other hand, the retracted position of the mirror M1 corresponds to the other self-supporting position of the plunger 124b. The retracted position of the mirror M1 may be freely placed insofar as the retracted position of the mirror M1 is removed from the optical path from the taking lens 301 to the CCD 302 and is in a range not contacting the screen 220, and slight error in the holding position of the plunger are allowed. A member for regulating the retracted position of the mirror M1 may be provided on either the mirror base 123 or the camera body 2. Furthermore, the plunger 124b also may be constructed so as to contact the cylinder 124c, so as to regulate the retracted position.

Although self support of the drive unit 124 is realized using the attraction force of the permanent magnets, the holding frame 122 also can be pressed against the mirror base 123 by the repulsion force of the permanent magnets.

Alternatively to using a self supporting type drive unit 124, the holding frame 122 may be pressed against the mirror base 123 by a spring when current is not applied, and the holding frame 122 may be moved to the retracted position against the force exerted by the spring when current is applied. In this construction, the power consumption is restricted to a minimum level in the optical finder modes 1 and 2 because power is supplied to the drive unit 124 only during photography by the CCD 302. Conversely, the holding frame 122 may be maintained at the retracted position by a spring when current is not applied, and moved to the advanced position against the force exerted by the spring when current is applied. In this construction, the power consumption is restricted to a minimum level in the liquid crystal finder mode.

In the digital camera 1 described above, the taking lens 301 can be housed within the camera body 2. In order to realize this arrangement, the mirror base 123 is constructed so as to be rotatable. The mirror base 123 has a hole for the insertion of the shaft 123c near the holes 123a and 123b for the insertion of the rotating shafts 125a and 125b of the holding frame 122. The shaft 123c is parallel to the rotating shafts 125a and 125b, and the bilateral ends are fixedly attached to the side

panel of the camera body 2. The mirror base 123 rotates around the shaft 123c.

A spring 126 is wrapped around one end of the rotating shaft 123c, and one end of the spring 126 is connected to the protrusion 125d provided on the side panel 125e of the camera body 2, and the other end of the spring 126 is connected to the protrusion 123d provided on the side of the mirror base 123. The spring 126 exerts a force on the mirror base 123 in the arrow A9 direction (the direction of the mirror M1 toward the retracted position). Provided on the side panel 125e of the camera body 2 is a protrusion 125c to contact the protrusion 123d of the mirror base 123, and in this way there is regulated rotation of the mirror base 123 in the arrow A9 direction via the force exerted by the spring 126. When the taking lens 301 is not housed, the mirror base 123 is set at an angle of 45° relative to the optical axis of the taking lens 301 maintained by the contact of the protrusion 123d with the protrusion 125c.

A protrusion 123e is formed on the bottom end of the mirror base 123. The protrusion 123e is formed in a smoothly curved shape, with the tip facing downward. FIG. 7 shows a cross section view of the digital camera 1 viewed from the side. Formed on the bottom back edge of

the lens barrel 3011 of the taking lens 301 is a protrusion 301e for contacting protrusion 123e of the mirror base 123. The dashed line in FIG. 7 represents the taking lens 301 housed in the camera body 2, and the
5 mirror base 123 at that time. When the taking lens 301 is not housed in the camera body 2, the protrusion 301e is separated from the protrusion 123e.

When the power switch PS is operated to issue instruction to stop the supply of power, the camera
10 control CPU 220 actuates the lens drive motor 221, and the taking lens 301 is moved in the arrow A1 direction in FIGS. 2 and 7. At the stage at which the taking lens 301 exceeds the focus adjustment range at the infinity end, the protrusion 301e of the lens barrel 3011 abuts the
15 protrusion 123e, and the mirror base 123 is pressed against the lens barrel 3011 by the movement of the taking lens 301, and rotates to the CCD unit 303 side around the rotating shaft 123c.

The camera control CPU 220 stops the actuation
20 of the motor 221 to stop the taking lens 301 at the stage at which a predetermined moving distance is reached from the infinity end of the focus adjustment range. At this time, the majority of the taking lens 301 is largely housed within the camera body 2, and the mirror base 123
25 is slightly separated from the focal plane shutter 26 and

approximately perpendicular to the optical axis of the taking lens 301 (represented by the dash-dot line in FIG. 2, and the dashed line in FIG. 7). The camera control CPU 220 stops the power supply to parts including the motor 221 simultaneously with stopping the actuation of the motor 221.

Preceding the housing operation, the camera control CPU 220 sets the quick return mirror M1 at the advanced position. In this way a collision between the mirror M1 and the taking lens 301 is avoided when the mirror M1 at the retracted position is erroneously rotated by the rotation of the mirror base 123. The camera control CPU 220 stops the power supply from the power unit E to the drive unit 124 after the quick return mirror M1 has been set at the advanced position. In this way, during the housing operation, a collision between the mirror M1 and the taking lens 301 is avoided due to erroneous rotation of the mirror M1 by the drive unit 124. Accordingly, when housing the taking lens 301, there is no concern of damage to the taking lens 301 or the mirror M1.

When the power switch PS is operated to issue instruction to start the supply of power, the camera control CPU 220 actuates the lens drive motor 221, and the taking lens 301 housed in the camera body 2 is moved

to a position allowing focus adjustment. The mirror base 123 on which is exerted the force of the spring 126 is rotated in the arrow A9 direction in FIG. 6 in conjunction with the movement of the taking lens 301 in a forward direction, and stops at the position at which the protrusion 123d abuts the protrusion 125c.

The camera control CPU 220 continues the actuation of the drive unit 221 even after the protrusion 301e of the lens barrel 3011 separates from the protrusion 123e of the mirror base 123, and stops the taking lens 301 when a predetermined standard position has been reached. This standard position may be at any location insofar as it is within a range between infinity and nearest focus positions, and is desirably set at a pan-focus position focused relative to the wide distance range so as to quickly provide a focused finder image to the user.

Even in control of the movement of the taking lens 301 to a focus adjustable position, the camera control CPU 220 stops the power supply from the power unit E to the drive unit 124 while the taking lens 301 is moving. this procedure avoids rotation of the quick return mirror M1 causing a collision with the taking lens 301 due to erroneous operation of the drive unit 124, and prevents actual damage to both elements. When the power

switch PS is operated to issue instruction to supply power, the camera control CPU 220 sends instructions to start the power supply to each part excluding the drive unit 124, and the power supply to the LCD 212 is executed in accordance with the setting of the selected photographic mode and display button 213.

FIG. 8 shows the flow of the control process of the drive unit 124 of the quick return mirror M1 and the drive unit 306 of the CCD unit displacement mechanism 307 in conjunction with a change of the photographic mode. First, a check is made to determine whether or not the photographic mode has changed by operation of the mode setting dial MODE, and a determination is made as to whether or not there has been a change from any of the optical finder mode 1, optical finder mode 2, liquid crystal finder mode to any other mode (step #102).

When there has been a change from the optical finder mode 2 to the optical finder mode 1, power is supplied to the drive unit 306 in the reverse direction, and the CCD unit 303 is moved to the front side (#104). Power is not supplied to the drive unit 124, and the quick return mirror M1 is held at the advanced position. When there is a change from the optical finder mode 2 to the liquid crystal finder mode, power is supplied to the drive unit 306 in the reverse direction, and the CCD unit

303 is moved to the front side (#106), and power is supplied to the drive unit 124 in the forward direction, and the mirror M1 is rotated to the retracted position (#108).

5 When there is a change from the optical finder mode 1 to the optical finder mode 2, power is supplied to the drive unit 306 in the forward direction, and the CCD unit 303 is moved to the back side (#110). Power is not supplied to the drive unit 124, and the mirror M1 is held
10 at the advanced position. When there is a change from the optical finder mode 1 to the liquid crystal finder mode, power is supplied to the drive unit 124 in the forward direction, and the mirror M1 is rotated to the retracted position (#112). Power is not supplied to the
15 drive unit 306, and the CCD unit 303 is held at the front side position.

 When there is a change from the liquid crystal finder mode to the optical finder mode 1, power is supplied to the drive unit 124 in the reverse direction,
20 and the mirror M1 is rotated to the advanced position (#114). Power is not supplied to the drive unit 306, and the CCD unit 303 is held at the front side position.
When there is a change from the liquid crystal finder mode to the optical finder mode 2, power is supplied to
25 the drive unit 306 in the forward direction, and the CCD

unit 303 is moved to the back side (#116), and power is supplied to the drive unit 124 in the reverse direction, and the mirror M1 is rotated to the advanced position (#118).

5 After each of the aforesaid controls, the process ends, or the process ends without action when the determination of step #102 is there has been no mode change.

FIG. 9 shows the flow of the control process
10 focusing on the actuation of the quick return mirror M1 when recording a photographed image. First, a check is made to determine whether or not a signal S2 specifying recording has been generated by operation of the shutter release button 9 (#202). When a signal S2 has not been
15 generated, the process ends. When a signal S2 has been generated, a determination is made as to whether or not the photographic mode at that moment is set at the optical finder mode 1 (#204).

When the mode is set at the optical finder mode
20 1, power is supplied to the drive unit 124 in the forward direction, the quick return mirror M1 is rotated to the retracted position (#206), the focal plane shutter 26 is opened, and light is directed to the CCD 302 (#208). Then, image processing is started, including
25 photoelectric conversion by the CCD 302 (#210). At the

moment a predetermined time corresponding to the shutter speed has elapsed, the shutter 26 is closed (#212), power is supplied to the drive unit 124 in the reverse direction, and the quick return mirror M1 is returned to the advanced position (#214).

The processes of steps #212 and #214 are executed in parallel, and processing of the image signals output by the CCD 302 and the recording image generation process are executed, and the generated image is recorded in the memory card 8, whereupon the process ends. When the CCD unit 303 is set at the back side at the moment the signal S2 is generated, a process to supply power to the drive unit 306 in the reverse direction and move the CCD unit 303 to the front side is executed simultaneously with the retraction of the mirror M1 in #206.

When the optical finder mode 1 is not set, i.e., when optical finder mode 2 or the liquid crystal finder mode is set, a process to open the shutter 26 (#216), photographic process (#218), and process to close the shutter 26 (#220) are sequentially executed, and actuation of the quick return mirror M1 is omitted. These modes are photographic mode wherein the mirror M1 is normally held at the retracted position or the advanced position, since the mirror M1 has been set at

the retracted position or the advanced position
beforehand.

The position of the CCD unit 303 is set
beforehand to match the position of the mirror M1 by the
5 controls during mode switching shown in FIG. 8.

FIG. 10 shows the flow of the control process
relating to ON/OFF switching of the LCD 212. First, it
is determined whether or not the display button 213 has
been operated (#302). If the button 213 has not been
10 operated, the process ends without action. If the button
213 has been operated, a check is made to determine
whether or not the LCD 212 is ON at that moment (#304).

When the LCD 212 is ON, a check is made to
determine whether or not the photographic mode is set at
15 the liquid crystal finder mode (LCD) (#306). If the
photographic mode is not the liquid crystal finder mode,
i.e., when either the optical finder mode 1 or 2 is set,
the LCD 212 is turned OFF by stopping the power supplied
thereto (#308), and the process ends. If the liquid
20 crystal finder mode is set, the process ends without
action. In this way, in the liquid crystal finder mode,
the operation of the display button 213 is invalid, and
the LCD 212 is forcibly kept ON.

When it is determined in step #304 that the LCD
25 212 is OFF, a check is made to determine whether or not

the photographic mode is set at the optical finder mode 1 (#310). When the optical finder mode 1 is set, power is supplied to the drive unit 306 in the forward direction, and the CCD unit 303 is moved to the back side (#312),

5 the elapse of the specific time required for this movement is awaited (#314), the LCD 212 is turned ON (#316), and the process ends. The display of an unfocused finder image is avoided by waiting for the end of the movement of the CCD unit 303. When the optical
10 finder mode 1 is not set, the LCD 212 is directly turned ON (#316), and the process ends. Since the LCD 212 is turned ON when the mode is set in the liquid crystal finder mode, the process does not advance from steps #304 to #310.

15 FIG. 11 is a cross section view of the digital camera 1A of a second embodiment viewed from the side. The majority of the construction of the digital camera 1A is identical to the digital camera 1 of the first embodiment, and structural elements having identical or
20 similar functions are designated by the same reference numbers; duplicate description is omitted and only the aspects of difference are described below. The digital camera 1A has the exterior view shown in FIGS. 1 and 3, and an LCD 212 is provided on the back of the camera body
25 2.

In the digital camera 1A, the difference in the optical path length from the taking lens 301 to the CCD 302 when the semitransparent quick return mirror M1 is set at the advanced position indicated by the solid line in FIG. 11 and when set at the retracted position indicated by the dashed line is corrected by displacement of the taking lens 301 along the optical axis. Specifically, when the quick return mirror M1 is held at the advanced position for photography, the taking lens 301 is displaced to the front side (arrow A10) more than when the mirror M1 is rotated to the retracted position for photography. The displacement of the taking lens 301 is executed with the same timing as the displacement of the CCD unit 303 in the digital camera 1 of the first embodiment. In the digital camera 1A, the CCD unit 303 is fixed within the camera body 2, and the previously described displacement mechanism including the drive unit 306 is not provided.

Although the difference in the optical path lengths is corrected by displacement of the taking lens 301 along the optical axis of the lens 301, when the mirror M1 is set at the advanced position the image forming position of the light on the CCD 302 is shifted below the image forming position when the mirror M1 is set at the retracted position. In the digital camera 1A,

the shifting of the center of the photographed image from the optical axis of the taking lens 301 caused by this shift of the image forming position is prevented by changing the processing of the image signal output from the CCD 302 in accordance with the position of the mirror M1.

The CCD 302 comprises 1600×1200 (horizontal × vertical) pixels; image signal processing is described using as an example the situation wherein the image forming position of the light flux at which the principal ray matches the optical axis of the taking lens 301 is shifted 40 pixels downward when the mirror M1 is set at the advanced position. The CCD 302 is shown schematically in FIG. 12. The positions on the CCD 302 are represented by (m,n) (where m=0~1599, and n=0~1199) with (0,0) as the origin in the upper left corner. In FIG. 12, the point P and point Q are the image forming positions of the light flux at which the principal ray matches the optical axis of the taking lens 301 when the mirror M1 is set at the retracted position and the advanced position, respectively.

In the digital camera 1A, when the mirror M1 is set at the retracted position, pixel data are generated by processing the image signals output from all pixels

within the range of (0,0)~(1599,1199), i.e., all pixels of the CCD 302, and these pixel data are designated the finder image displayed on the LCD 212, and the image recorded on the memory card 8. On the other hand, when
5 the mirror M1 is set at the advanced position, the pixels within the range (0,0)~(1599,79), i.e., pixels of the top 80 lines of the CCD 302, are not processed, and the only the image signals output from the remaining pixels within the range of (0,80)~(1599,1199) are processed and
10 designated the finder image and the recording image.

According to this process, the optical axis of the taking lens 301 normally passes through the center of the photographed image regardless of whether the mirror M1 is set at the retracted position or the advanced
15 position. Furthermore, when the mirror M1 is set at the advanced position, the light from the taking lens 301 does not enter part of the range (0,0)~(1599,79) so as to generate eclipse of the image on the CCD 302, but this area of eclipse is eliminated by the aforesaid process.

20 Alternatively, image signals output from all pixels of the CCD 302 may be processed to generate pixel data, and only part of the generated pixel data read from the image memory 209 and used for display on the LCD 212 and recorded to the memory card 8.

In the digital camera 1A wherein the position of the taking lens 301 changes when the quick return mirror M1 is set at the advanced position and set at the retracted position, the optical path length from the taking lens 301 to the screen 220 is not fixed, and the situation arises wherein the image on the screen 220, i.e., the optical finder image, may not be focused although the image on the CCD 302, i.e., the photographed image, is focused.

10 In the digital camera 1A, in order to match the optical path lengths when photographing with the mirror M1 set at the advanced position, when the taking lens 301 is displaced to the front, the screen 220 is displaced downward (arrow A11 in FIG. 11), and the eyepiece lens 15 226 is displaced foreword (arrow A12). The amount of displacement of the screen 220 and the eyepiece lens 226 is identical to the amount of displacement of the taking lens 301. The optical finder 22 is provided with a drive unit 400 for displacing the screen 220, and a drive unit 20 401 for displacing the eyepiece lens 226.

These drive units 400 and 401 are of the self supporting type and have constructions identical to the drive unit 306 of the CCD unit displacement mechanism 307 of the digital camera 1 of the first embodiment, 25 Accordingly, electrical power is not required to maintain

the screen 220 at the position before displacement represented by the solid line, or the position after displacement indicated by the dashed line, and electrical power is unnecessary even to maintain the position of the eyepiece lens 226.

According to this construction and controls, the optical finder 22 and the LCD 212 also may be used simultaneously in the digital camera 1A. According to this image process, the photographic range when the mirror M1 is set at the advanced position becomes narrower in the vertical direction than the photographic range when photographing with the mirror M1 rotated to the retracted position. When setting the composition using the optical finder 22, the finder image provided by the optical finder 22 includes the photographic frame representing the photographic range since the photographic range is well defined.

FIG. 13 shows a photographic frame F when the mirror M1 is set at the advanced position. The user can know the part within the photographic frame F that is the actual photographic range in the image formed on the entire screen 220. The display of the photographic frame F is accomplished by a transparent type LCD 220a provided closely on the top surface of the screen 220, as shown in FIG. 11. Although the photographic frame may be

displayed even when the mirror M1 is rotated to the retracted position for photography, this is unnecessary since the entire screen 220 corresponds to the entire photoreception range of the CCD 302.

5 When the image photographed with the mirror M1 set at the advanced position is displayed on the LCD 212, blank area is produced in part of the LCD 212. With reference to FIG. 14, the display of the LCD 212 is described below using as an example the situation wherein
10 the LCD 212 comprises 400×300 (horizontal × vertical) pixels and the previously described settings of the CCD 302. The positions on the LCD 212 are represented by (j,k) (where j=0~399, and k=0~299) with (0,0) as the origin in the upper left corner.

15 The photographed image is displayed, for example, in the range (0,20)~(399,299). At this time, since the range (0,0)~(399,19) is blank, a message such as [semitransparent mirror ON] is displayed to alert the user that the quick return mirror M1 is set at the
20 advanced position. In this way the photographer avoids confusion caused by the change in the photographic range by effectively using the area unused by the photographed image. This message also may include camera settings directly related to photography such as stop and shutter

speed set values (Av, Tv) and the like, as well as other information, e.g., date/time, remaining battery power, remaining capacity of the memory card 8 and the like.

In the digital cameras 1 and 1A of the
5 previously described embodiments, the change in the optical path from the taking lens 301 to the CCD 302 is corrected by changing the position of the CCD 302 or the taking lens 301 depending on whether or not the semitransparent mirror M1 is on the optical path, such
10 that the optical path length from the taking lens 301 to the CCD 302, or this optical path length and the impingement of the light on the CCD 302 are normally fixed.

This control is not limited to a
15 semitransparent mirror, and may be applied to all optical elements. For example, any element among the spatial low pass filter 304 integrally formed with the CCD 302, infrared cutting filter 305, and ND filter 3107 disposed within the taking lens 301 may be arranged on the optical
20 path from the taking lens 301 to the CCD 302, and the difference in the optical path when the optical element is set at a position on the optical path and when the optical element is retracted from the optical path can be corrected in accordance with the previously described
25 control.

This control may be applied not only when changing the position of an optical element by rotation, but also when changing via movement without rotation. The control also may be used when the optical element
5 perpendicularly intersects the optical path.

In the aforesaid digital cameras having a semitransparent mirror as a quick return mirror, the display unit normally may be used as a finder, and the optical finder may be used by setting the semitransparent
10 mirror to the retracted position. Furthermore, since all the light from the taking lens is directed to the image sensing element by setting the semitransparent mirror to the retracted position, it is possible to photograph a bright image even in a dark environment, and the shutter
15 speed, i.e. Tv can be increased in a bright environment.

In a construction wherein the difference in the optical path depending on the position of the semitransparent mirror can be eliminated by changing the position of the image sensing element to correspond to
20 the position of the semitransparent mirror such that the light entering the image sensing element is equalized when the semitransparent mirror is set at the advanced position and set at the retracted position, there is increased freedom in selecting the position of the

semitransparent mirror and greater diversification in the use of the finder.

Similar effectiveness can be obtained in a construction wherein the optical path length from the taking lens to the image sensing element is equalized when the semitransparent mirror is set at the advanced position and set at the retracted position by changing the position of the taking lens in correspondence with the position of the semitransparent mirror. Since the screen and eyepiece lens of the optical finder are changed in accordance with the position of the taking lens, the optical finder image normally represents correctly the image forming state of the photographed image. The region of the image sensing element used for photography or the region of the photographed image used for display change in accordance with the position of the semitransparent mirror, so as to prevent shifting of the recording image and the display image.

In a digital camera having a photographic mode wherein the semitransparent mirror is retracted for photography to record an image and a photographic mode wherein semitransparent mirror normally remains at the advanced position, a bright image is obtained using the former photographic mode, and an image unaffected by

vibration due to the rotation of the semitransparent mirror is obtained in the latter photographic mode.

In a digital camera using a semitransparent mirror as a quick return mirror and having a photographic mode wherein the semitransparent mirror is set at the retracted position only when photographing an image for recording and a photographic mode wherein semitransparent mirror normally remains at the advanced position, characteristics of an optical finder and characteristics of a display unit as a finder are both attained in the former photographic mode. For example, an unblurred image can be observed using the optical finder even when the object is moving rapidly, and the image displayed on the display unit can be used for confirmation when the user desires to know the true color balance of the image to be recorded. In the latter photographic mode, an image completely unaffected vibration due to rotation of the semitransparent mirror can be photographed using the characteristics of the display unit.

In this digital camera, difference in the optical path length caused by the position of the semitransparent mirror can be eliminated by changing the position of the image sensing element or the taking lens in accordance with the position of the semitransparent mirror, and there is increased freedom in selecting the

position of the semitransparent mirror and greater diversification in the use of the finder.

In the digital camera wherein the optical path length from the taking lens to the image sensing element is rendered fixed regardless of the position of optical element by arranging a retractable optical element at an inclination in the optical path from the taking lens to the image sensing element, and changing the position of the taking lens in conjunction with the position of the optical element, a specific optical element can be advanced onto the optical path as necessary, and the image formation state on the image sensing element does not change whether this optical element is set at the advanced position or the retracted position. Accordingly, the focus of the photographed image is unaffected, and the conventional function of the optical element is usable.

Similar effectiveness can be obtained in a digital camera wherein the light impinging the image sensing element is rendered fixed regardless of the position of the optical element by arranging a retractable optical element on the optical path from the taking lens to the image sensing element, and changing the position of the image sensing element in accordance with the position of the optical element.

Although the present invention has been fully described by way of examples with reference to the accompanying drawings, it is to be noted that various changes and modification will be apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the present invention, they should be construed as being included therein.

What is claimed is:

1. A digital camera comprising:

an image sensor disposed at a position at which
5 an image is to be formed by a taking lens;

a recorder for recording on a recording medium
an image sensed by said image sensor in accordance with
recording instructions;

a semitransparent mirror which rotates about an
10 axis in a direction perpendicular to the optical axis of
the taking lens so as to move between an advanced
position intersecting at an inclination the optical path
from the taking lens to the image sensor, and a retracted
position removed from the optical path; and

15 an optical finder providing an image by
directing the light reflected by said semitransparent
mirror set at the advanced position from the taking lens
to the eye of an user.

20 2. A digital camera according to claim 1, wherein
said semitransparent mirror is a quick return mirror.

3. A digital camera according to claim 1, wherein
said image sensor is movable between a first position and
25 a second position, and said image sensor is positioned in

the first position when said semitransparent mirror is in the retracted position and positioned in the second position when said semitransparent mirror is in the advanced position,

5 wherein the second position with said semitransparent mirror intersecting the optical path and the first position without said mirror are optically equivalent with each other.

10 4. A digital camera according to claim 3, wherein the first position and the second position are set so as to equalize the optical path length from the taking lens directly to said image sensor when said semitransparent mirror is set at the retracted position, and the optical
15 path length from the taking lens through said semitransparent mirror to said image sensor when said semitransparent mirror is set at the advanced position.

5. A digital camera according to claim 3, wherein
20 the first position and the second position are set so as to equalize the imaging position of an image formed by the taking lens directly on said image sensor when said semitransparent mirror is set at the retracted position, and the imaging position of an image formed by the taking
25 lens through said semitransparent mirror on said image

sensor when said semitransparent mirror is set at the advanced position.

6. A digital camera according to claim 1 further
5 comprising a driver for moving the taking lens between a first position and a second position in a direction along the optical path, the first position and the second position are set so as to equalize the optical path length from the first position directly to said image
10 sensor when said semitransparent mirror is set at the retracted position, and the optical path length from the second position through said semitransparent mirror to said image sensor when said semitransparent mirror is set at the advanced position.

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7. A digital camera according to claim 1, wherein said digital camera is controllable under a first photographic mode wherein said semitransparent mirror is set at the advanced position until recording is
20 instructed, and set at the retracted position when recording has been instructed, and returns to the advanced position again when said image sensor completes the sensing of the image, and a second photographic mode wherein said semitransparent mirror is set at the

advanced position regardless of whether or not the recording is instructed.

8. A digital camera according to claim 1 further comprising a display for displaying an image sensed by said image sensor.

9. A digital camera according to claim 8, wherein said digital camera is controllable under a first photographic mode wherein said semitransparent mirror is set at the advanced position until recording is instructed, and set at the retracted position when recording has been instructed, and a second photographic mode wherein said semitransparent mirror is set at the retracted position regardless of whether or not the recording is instructed.

10. A digital camera comprising:
an image sensor disposed at a position at which an image is to be formed by a taking lens; and
an optical element movable between an advanced position intersecting at an inclination the optical path from the taking lens to said image sensor, and a retracted position removed from the optical path,

wherein said digital camera is controllable under a first photographic mode wherein said optical element is set at the advanced position for photography, and a second photographic mode wherein said optical element is set at the retracted position for photography, and the optical path lengths from the taking lens to said image sensor are equalized in the first photographic mode and the second photographic mode by moving the taking lens in a direction along the optical axis of the taking lens.

11. A digital camera according to claim 10, wherein said optical element is at least a single element for photography.

12. A digital camera according to claim 11, wherein said optical element is at least one of semitransparent mirror, infrared cutting filter, spatial modulation element and ND filter.

13. A digital camera according to claim 10, wherein said optical element is moved between the advanced position and the retracted position by rotation.

14. A digital camera according to claim 10, wherein said optical element is moved between the advanced position and the retracted position by a movement other than rotation.

5

15. A digital camera according to claim 10, wherein said image sensor is movable between a first position and a second position, and said image sensor is positioned in the first position when said optical element is in the retracted position and positioned in the second position when said optical element is in the advanced position,

wherein the second position with said optical element intersecting the optical path and the first position without said optical element are optically equivalent with each other.

10
15

16. A digital camera according to claim 15, wherein the first position and the second position are set so as to equalize the optical path length from the taking lens directly to said image sensor when said optical element is set at the retracted position, and the optical path length from the taking lens through said optical element to said image sensor when said optical element is set at the advanced position.

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17. A digital camera according to claim 15, wherein the first position and the second position are set so as to equalize the imaging position of an image formed by the taking lens directly on said image sensor when said optical element is set at the retracted position, and the
5 imaging position of an image formed by the taking lens through said optical element on said image sensor when said optical element is set at the advanced position.

ABSTRACT OF THE DISCLOSURE

A rotatable semitransparent mirror is arranged at an inclination above the optical path from the taking lens to the image sensing element, and the light
5 reflected by the semitransparent mirror is directed to an optical finder provided above the mirror. The image sensed by the image sensing element is displayed on a liquid crystal display. The variation in the optical path from the taking lens to the image sensing element
10 depending on whether or not the semitransparent mirror is set on the optical path is corrected by changing the position of the image sensing element or the taking lens, such that the impingement state of the light on the image sensing element or the optical path length from the
15 taking lens to the image sensing element is normally rendered fixed. Both the image provided by the optical finder and the image displayed by the liquid crystal display accurately represent the image forming state on the image sensing element regardless of whether or not
20 the semitransparent mirror is set on the optical path.

Fig.1

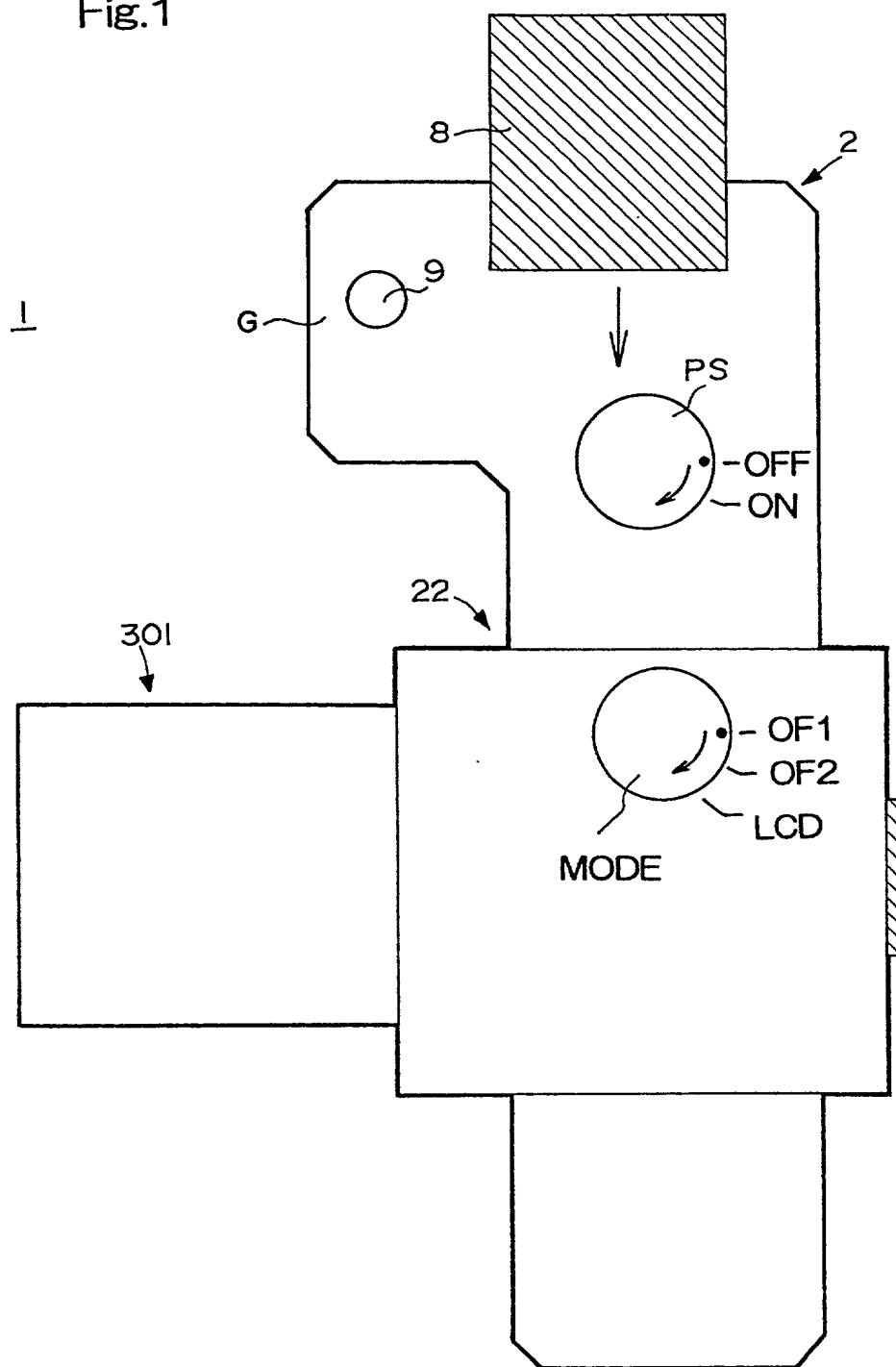


Fig.2

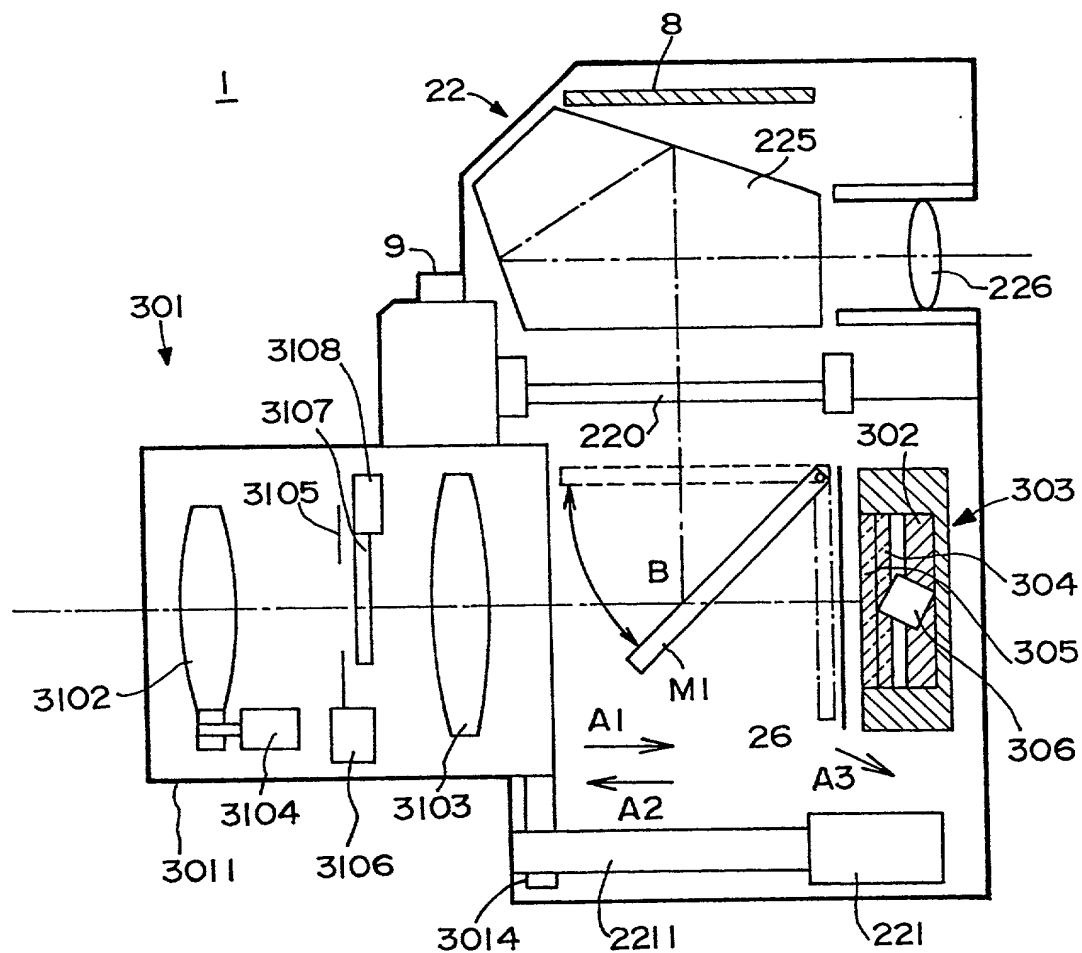


Fig.3

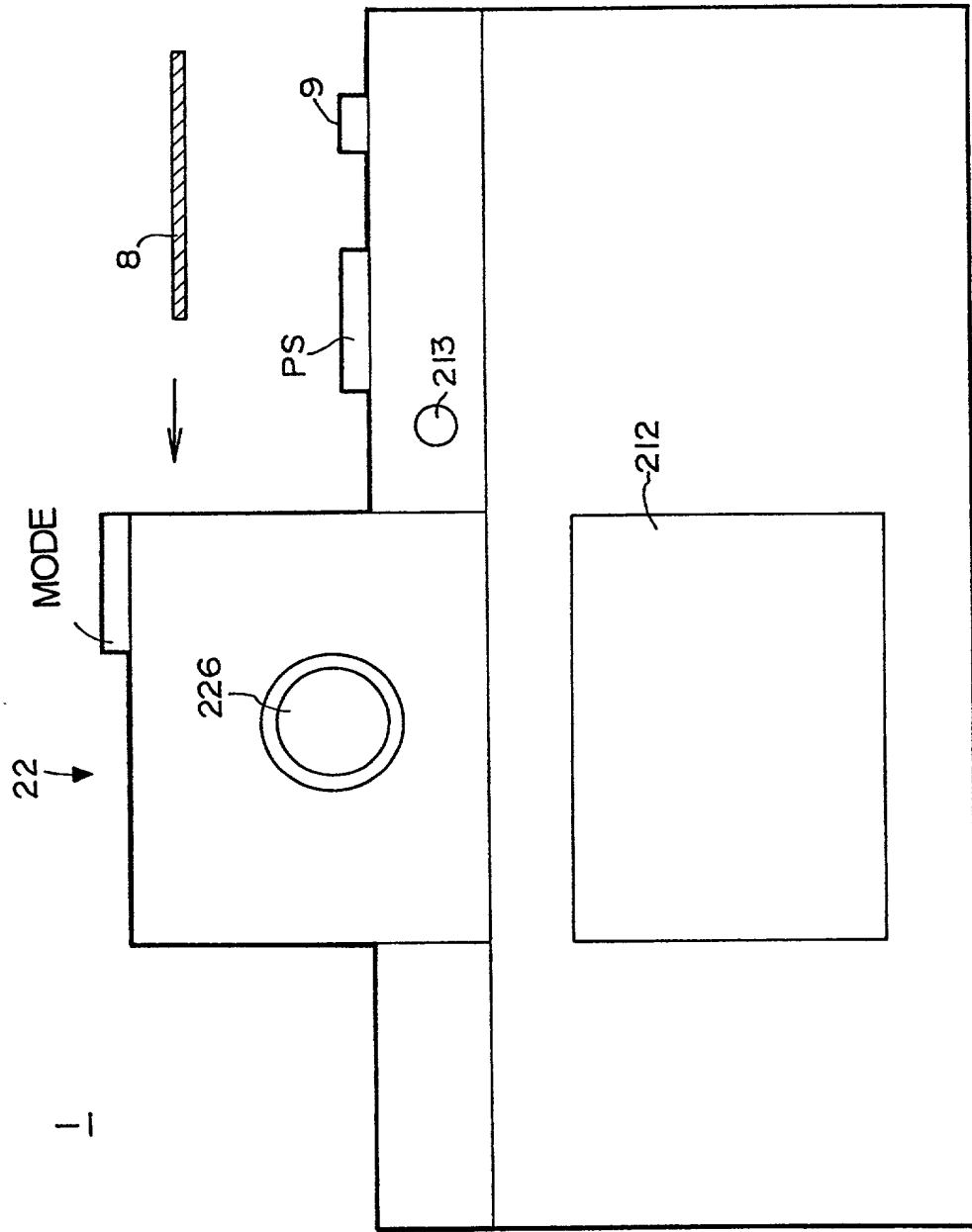
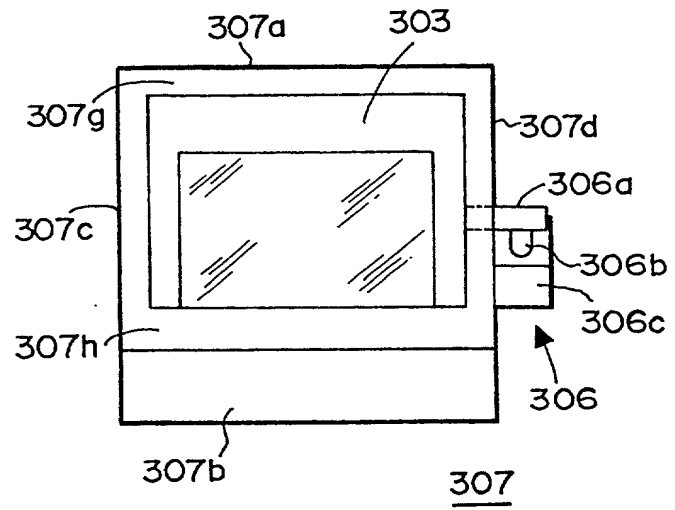
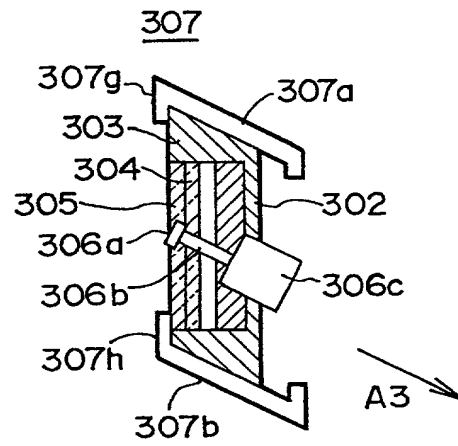


Fig.4

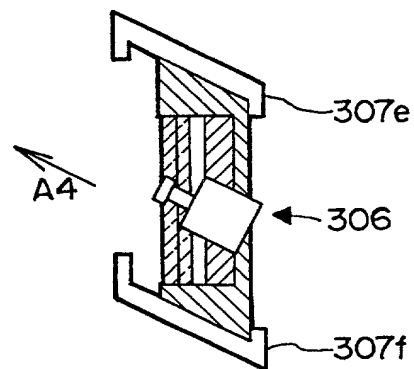
(a)



(b)



(c)



1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143	2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160	2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207	2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223	2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240	2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287	2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320	2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348	2349	2350	2351	2352	2353	2354	2355	2356	2357	2358</
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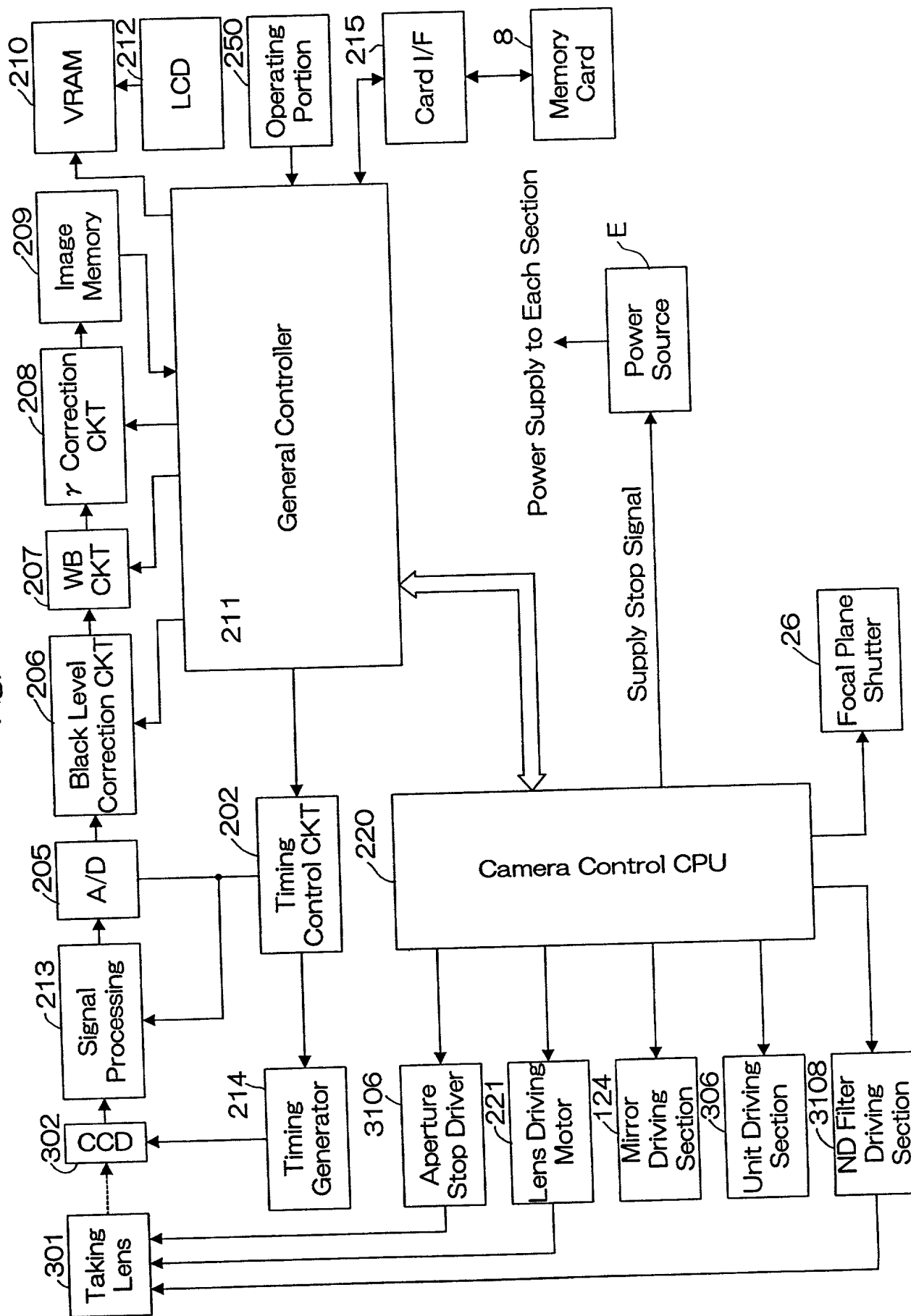


Fig.6

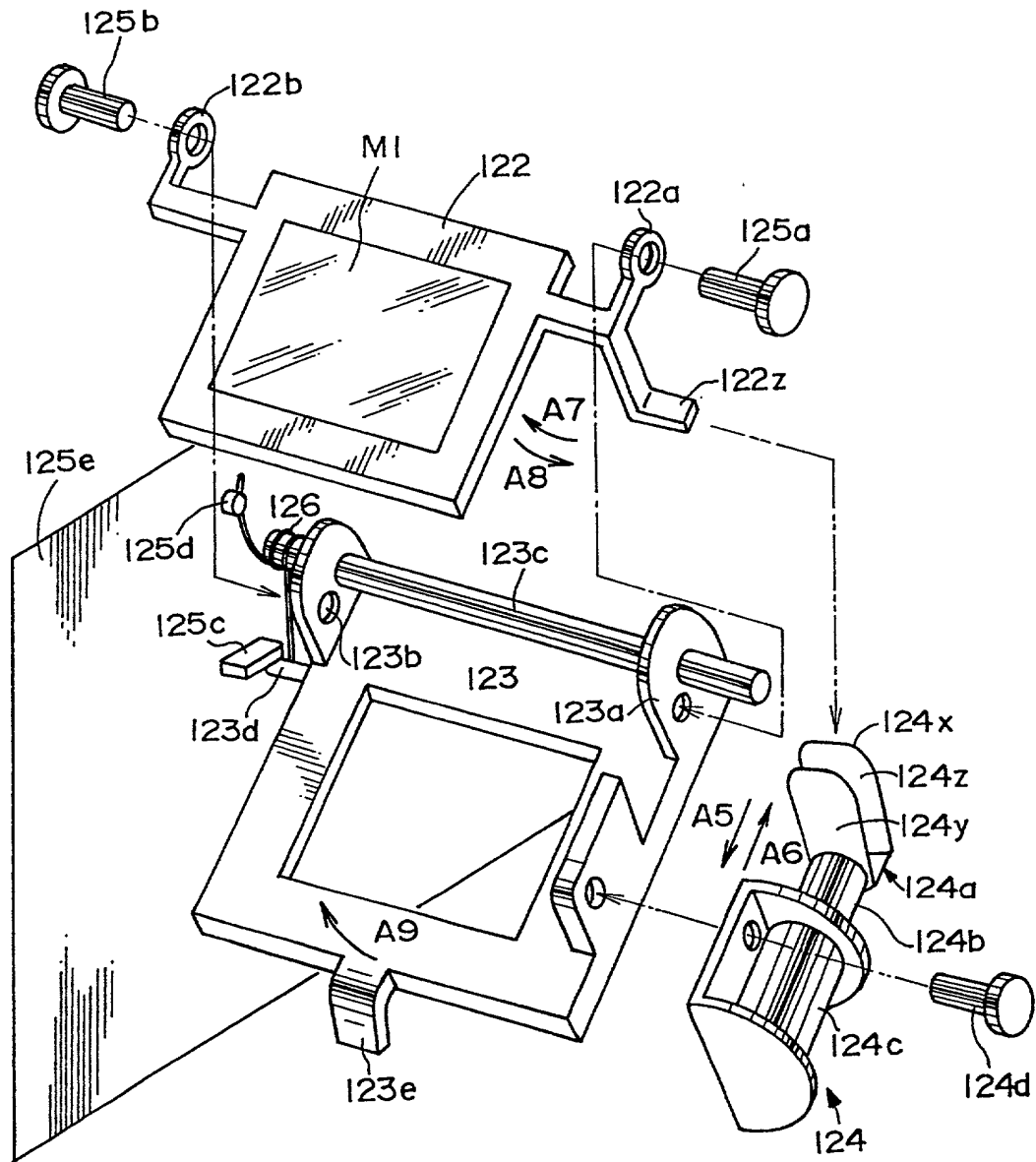


Fig.7

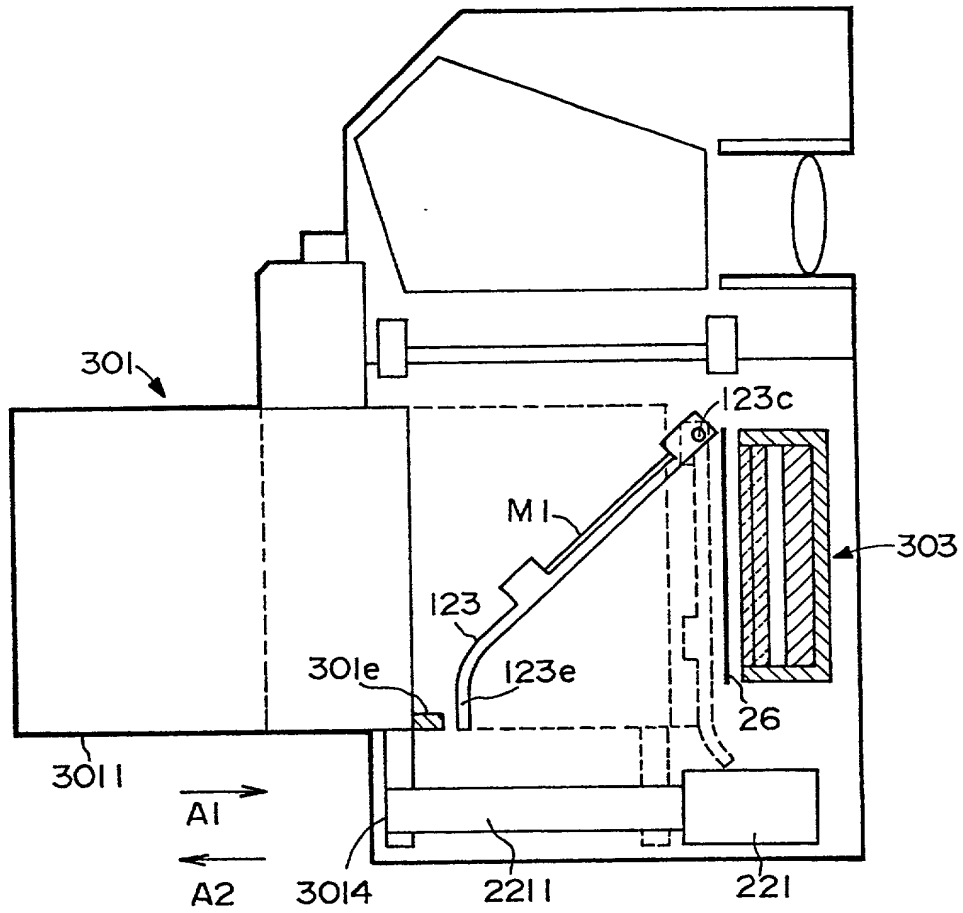


Fig.8

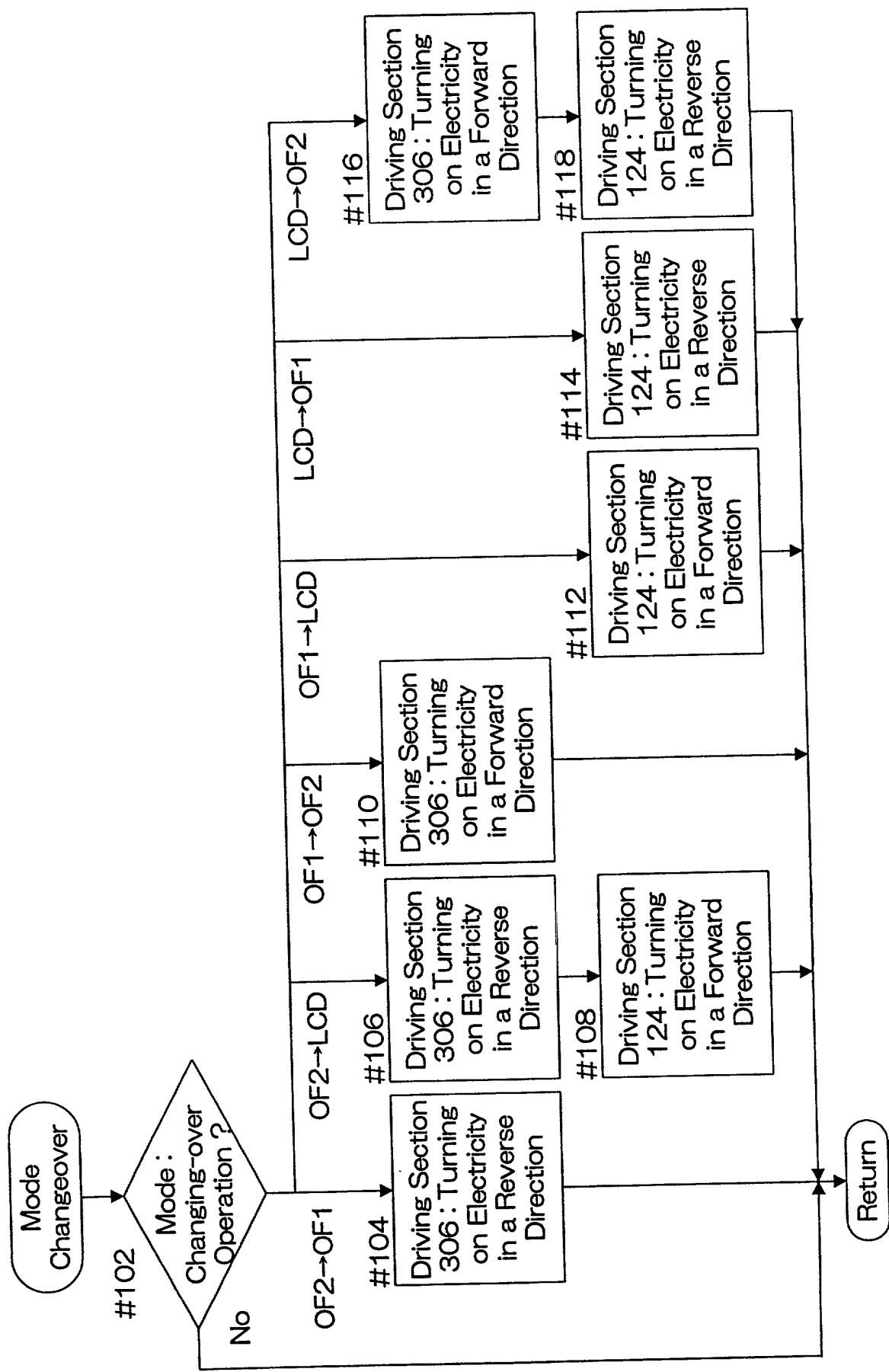


Fig.9

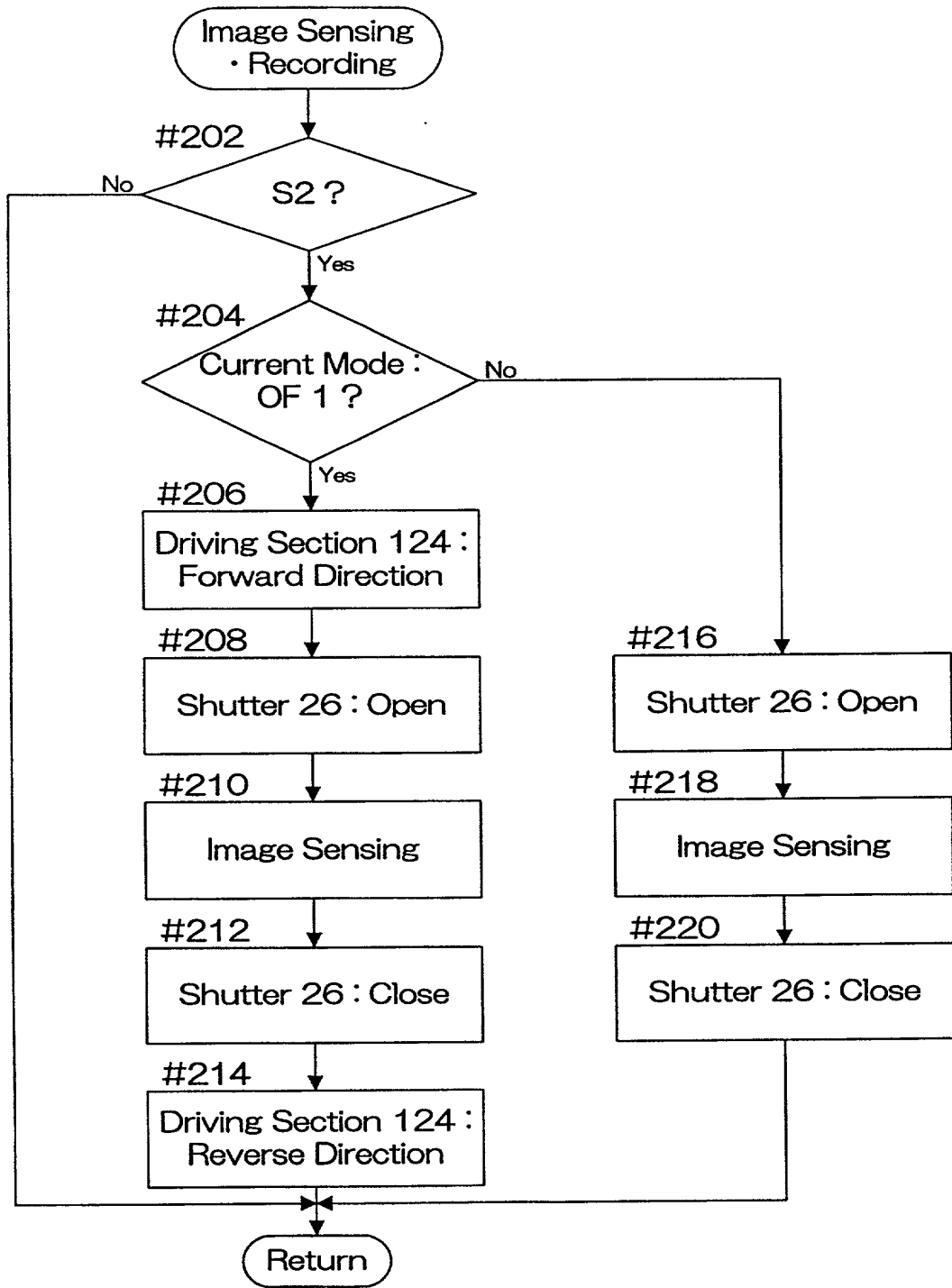


Fig.10

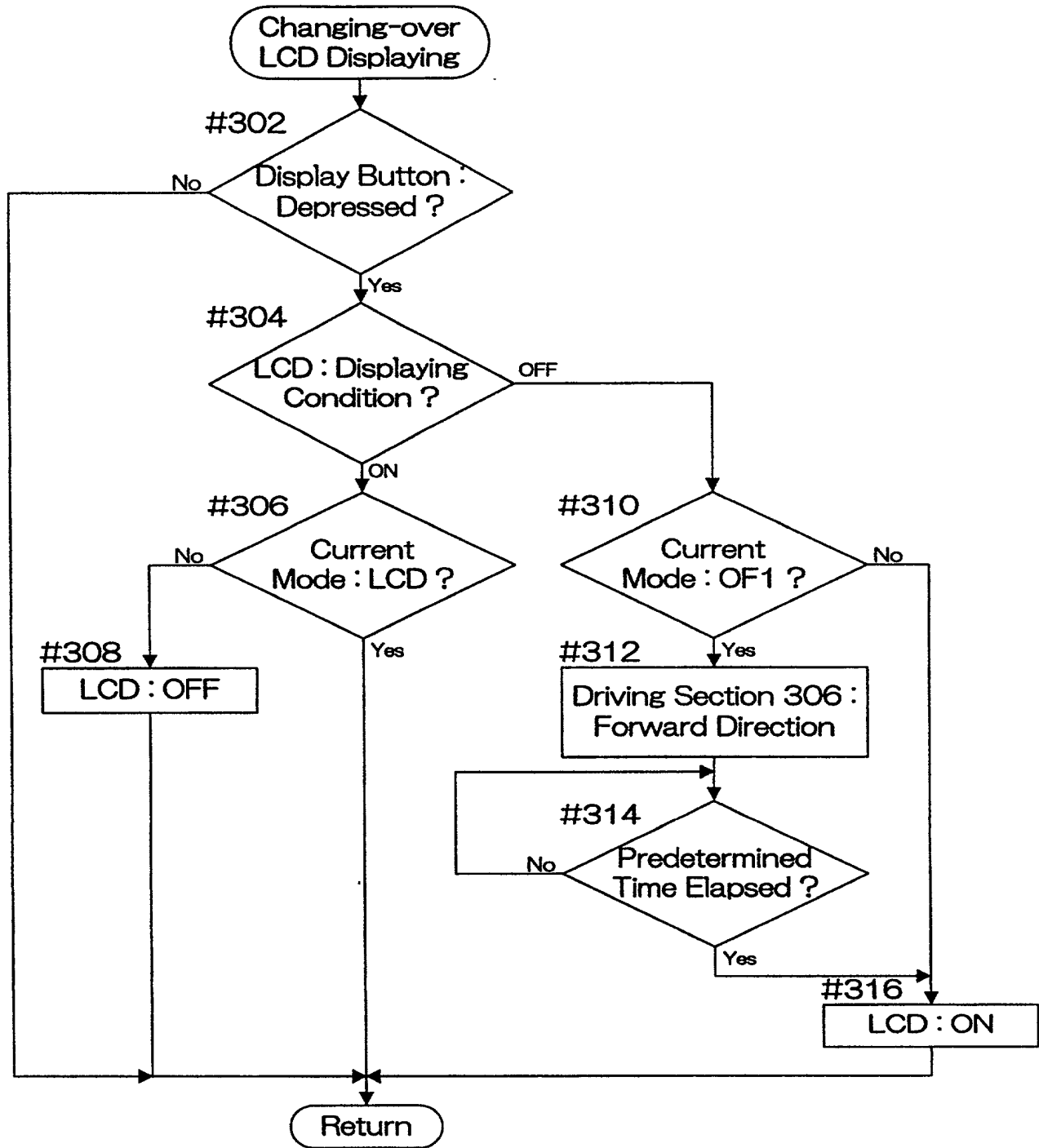


Fig.12

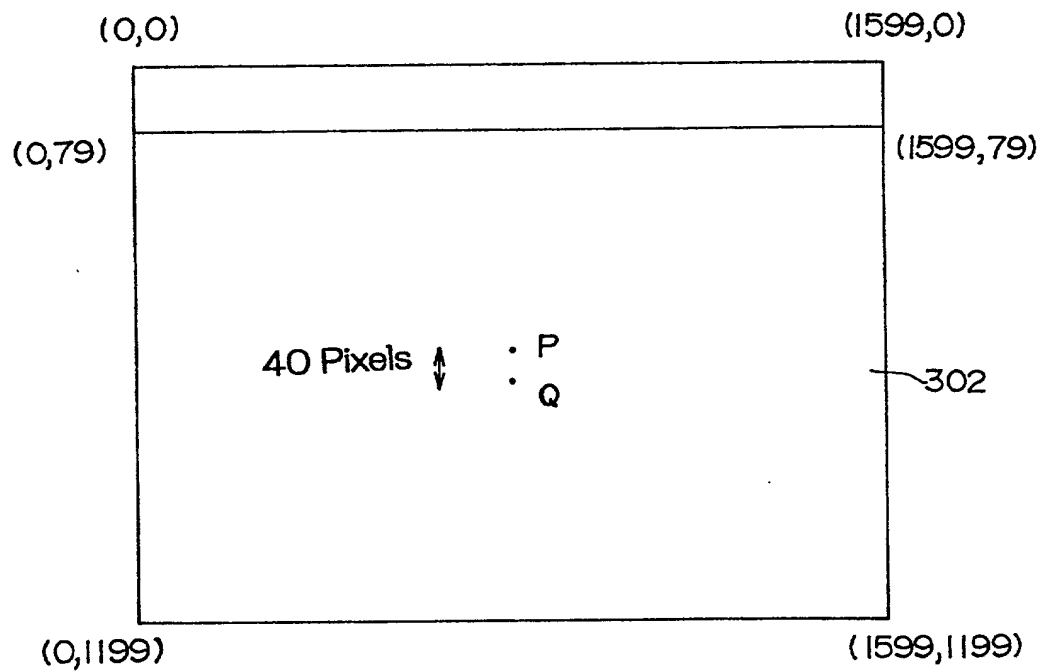


Fig.13

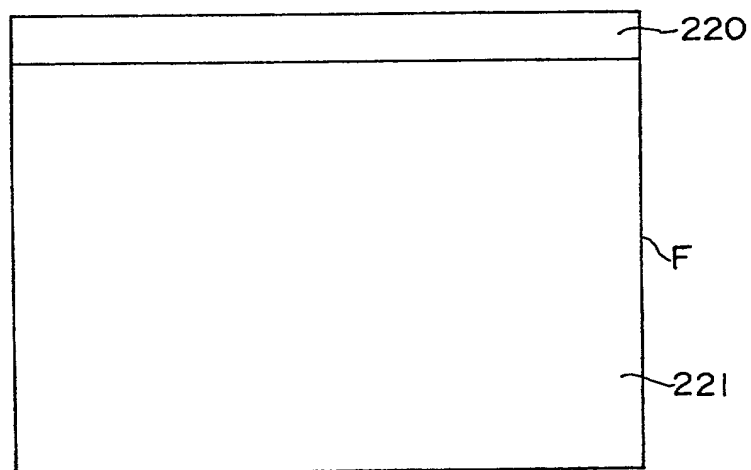
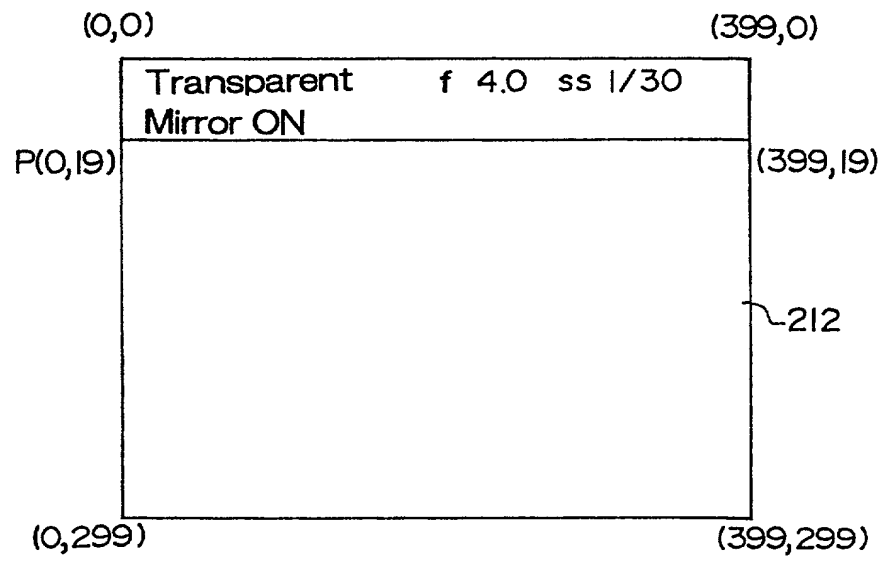


Fig.14



Attorney Docket No.

1

DECLARATION AND POWER OF ATTORNEY

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe that I and the other joint inventors named below are the original, first and joint inventors of the subject matter which is claimed and for which a patent is sought on the invention or discovery entitled

DIGITAL CAMERA

the specification of which

(check one) X is attached hereto.

 was filed on as

Application Ser. No. .

I have reviewed and understand the contents of the above-identified specification, including the claims; and

I acknowledge the duty to disclose to the Patent and Trademark Office all information known to me which is material to patentability as defined in 37 C.F.R. § 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. § 119/365 of any foreign application for patent or inventor's certificate as listed below or of any PCT international application, designating at least one country other than the United States of America, as listed below and have also identified below any foreign application for patent or inventor's certificate or any PCT international application, designating at least one country other than the United States of America, directed to said invention or discovery and having

a filing date before that of the applications on which priority is claimed:

<u>NUMBER</u>	<u>COUNTRY</u>	<u>DATE FILED</u>	<u>PRIORITY CLAIMED</u>	
			(Yes)	(No)
11-276621	Japan	September 29, 1999	X	

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all of the firm of SIDLEY & AUSTIN, my representatives with full power of substitution and revocation, to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith, and to file and prosecute any international patent applications filed thereon before any international authorities under the Patent Cooperation Treaty.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that

these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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